

# **TECHNICAL MANUAL**

**DIRECT AND GENERAL SUPPORT**

**MAINTENANCE MANUAL**

**GRADER, ROAD, MOTORIZED, DED, TYPE I  
6 WHEEL, 4 WHEEL DRIVE, FRONT WHEEL STEERING**

**SIZE 4, 12-FOOT BLADE**

**(CATERPILLAR MODEL 120)**

**FSN 3805-466-0084**

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pages from Changes 1

**HEADQUARTERS, DEPARTMENT OF THE ARMY  
MAY 1971**

### **WARNING**

**Wear safety glasses and protective clothing when prescribed by the job.**

**Store flammable liquids in safe containers.**

**Avoid moving parts.**

**Turn the disconnect switch off and disconnect battery cables before servicing the electrical system.**

**Allow the engine to cool before working in the engine compartment.**

**Use proper tools. Keep tools clean and in good condition.**

**Install warning tags on the steering wheel if the vehicle is in unsafe operating condition or if any system or component has been drained.**

**Install all covers and guards when work is complete.**

**Lower the blade and scarifier to the ground when working on the vehicle or when leaving the vehicle unattended.**

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
Washington, D. C. 27 December 1971

Change }  
No. 1 }

**Direct and General Support Maintenance Manual**  
**GRADER, ROAD, MOTORIZED; DED; TYPE-1; 6 WHEEL, 4 WHEEL DRIVE, FRONT WHEEL**  
**STEERING; SIZE 4; 12-FOOT BLADE (CATERPILLAR MODEL 120)**  
**FSN 3805-466-0084**

TM 5-3805-249-34, 13 May 1971, is changed as follows:

*Page 1-1.* Paragraph 1-3 is superseded as follows: 1-3. Equipment Serviceability Criteria. Refer to TM 5-3800-201-ESC.

*Page 1-5.* Paragraph 1-7b(23), add the following:

**NOTE**

12 inch pounds equal 1 foot pound.

*Page 2-3.* Table 2-2, item 4b, Corrective Action column, (TM 5-3805-149-12) is changed to read (TM 5-3805-249-12).

*Table 2-2.* Malfunction column, item 5 is superseded as follows: Engine stalls at low RPM.

*Page 2-7.* Section II. Troubleshooting, add items 40 through 44.

*Table 2-2 Troubleshooting*

Malfunction	Probable Cause	Corrective Action
40. Moldboard does not lift or lower.	a. Defective clutch. b. Defective lift gear assembly.	a. Repair or replace power control box. (para. 2-10) b. Repair or replace lift gear assembly (para. 2-12)
41. Moldboard does not circle properly.	c. Shear pin sheared a. Circle binding b. Defective circle drive pinion. c. Defective circle reverse gear assembly.	c. Install new shear pin (fig. 5-3-16) a. Check cause and repair or replace circle (para. 6-4) b. Repair or replace drive pinion (para. 5-8). c. Repair or replace circle reverse gear assembly (para. 5-8).
42. Moldboard does not shift properly.	d. Defective circle reverse transfer gear. a. Defective power control box. b. Defective center shift gear assembly.	d. Repair or replace transfer gear (para. 5-7). a. Repair or replace power control box (para. 5-2). b. Repair or replace center shift gear assembly (para. 5-9).
43. Moldboard does slide properly.	a. Defective hydraulic system. b. Defective moldboard cylinder. c. Moldboard slides damaged. d. Defective hydraulic junction.	a. Repair or replace hydraulic system as necessary (para. 8-5). b. Repair or replace moldboard cylinder (para. 8-10). c. Repair or replace slides (para. 4-79, TM 5-3805-249-12). d. Repair or replace hydraulic junction. (para. 8-8).
44. Scarifier does not lift or lower.	a. Defective power control box.	a. Repair or replace power control box. (para. 5-2).

*Page 2-10.* Paragraph 2-8a(7). Step (8) is added after step (7).

(8) Remove the tool box and the near cross member.

*Paragraph 2-8a(8).* Sub-paragraph (8) is renumbered (9).

*Page 3-3.* Paragraph 3-2d(2) is superseded as follows:

(2) Immerse in water. Apply an air pressure not to exceed 12 PSI and check for leaks. Repair leaks using a soft solder composed of 35- to 45-% tin and 55- to 65-% lead. Use a zinc chloride or resin flux. Flush the core with water. Check for restrictions.

*Page 3-24.* Paragraph 3-19a(16) is superseded as follows:

(16) Remove the precombustion chambers (29) and seals (30 and 31) using the precombustion chamber wrench (FSN 5120-157-0718).

*Paragraph 3-19c(5),* is superseded as follows:

(5) Inspect cylinder head for damage, erosion or warping in excess of 0.005 inch. Replace if necessary.

*Paragraph 3-19d(5) & (6).* Subparagraph (5) is renumbered (6) and subparagraph (6) is renumbered (5).

*Page 3-27.* Paragraph 3-21a(13), in line 1 "hydraulic" is changed to read "suitable".

*Page 4-6.* Paragraph 4-4a(14), the word "caution" is added ahead of last sentence.

*Page 4-26.* Paragraph 4-11a(11), in line 1 "hydraulic" is changed to read "suitable".

*Paragraph 4-11a(13).* In line 1, "hydraulic" is changed to read "suitable".

*Paragraph 4-11d(1).* In line 2 callout (14) is changed to read (26).

*Paragraph 4-11d(3).* In line 2, callouts (16) and (17) are changed to read (18) and (19).

*Page 4-28,* paragraph 4-12a(19), in line 2, "hydraulic" is changed to read "suitable".

*Paragraph 4-12d(10)* In line 3, correct spelling of "retighten".

*Page 4-30,* paragraph 4-16a(3), in line 2, "master cylinder" is changed to read "wheel cylinder".

*Page 4-31,* paragraph 4-17b is superseded and paragraph c is renumbered f.

#### *b. Disassembly.*

(1) Remove the boot and the piston link from both ends of the cylinder.

(2) Remove the pistons, cups, and spring.

*Paragraphs c, d, and e* are added as follows:

*c. Cleaning.* Clean all components in solvent and dry with compressed air.

#### *d. Inspection and Repair.*

##### NOTE

A wheel cylinder rebuild kit is available.

(1) Inspect the bore of the cylinder for wear, pitting or cracks. The cylinder may be used again if it can be honed smooth.

(2) If the pistons are worn, damaged, or pitted excessively, they must be replaced.

(3) Use new cups and boots when assembling the cylinder.

##### NOTE

Swollen or distorted cups indicate the possibility of mineral oil being present in the system. If this condition exists, the entire braking system should be drained and cleaned with alcohol. Fill the system with brake fluid in accordance with the instructions in TM 5-3805-249-12.

#### *e. Reassembly.*

(1) Assemble the cups with the lipped edge toward the spring or center of the wheel cylinder.

(2) Install the pistons with the flat portion of the piston fitting against the back of the cup.

(3) Install new boots and the piston link.

*Page 5-11,* paragraph 5-8b(9), in line 4 "hydraulic" is changed to read "suitable".

*Page 9-1,* paragraph 9-1c, add:

##### WARNING

Use extreme caution when welding fuel containers. Insure removal of flammable liquids and fumes before lighting or using welding equipment.

*Paragraph 9-2* is rescinded.

Figure 9-1 is rescinded.



By Order of the Secretary of the Army:

**W. C. WESTMORELAND,**  
*General, United States Army,*  
*Chief of Staff.*

Official:

**VERNE L. BOWERS,**  
*Major General, United States Army,*  
*The Adjutant General.*

Distribution:

To be distributed in accordance with DA Form 12-25B (qty rqr Block No. 395), Direct/General Support requirements for Earth Moving Equipment: Graders.

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HEADQUARTERS,  
 DEPARTMENT OF THE ARMY  
 WASHINGTON, D. C., 13 May 1971

## DIRECT AND GENERAL SUPPORT MAINTENANCE MANUAL

### GRADER, ROAD, MOTORIZED, DED, TYPE I, 6 WHEEL,

### 4 WHEEL DRIVE, FRONT WHEEL STEERING, SIZE 4, 12 FT BLADE

### (CATERPILLAR MDL 120)

FSN 3805-466-0084

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**GRADER, ROAD, MOTORIZED, DED, TYPE I, 6 WHEEL,**  
**4 WHEEL DRIVE, FRONT WHEEL STEERING, SIZE 4, 12 FT BLADE**  
**(CATERPILLAR MDL 120)**

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# **CHAPTER 1**

## **INTRODUCTION**

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### **Section I. GENERAL**

#### **1-1. Scope**

These instructions are published for the use of personnel who are issued the Model 120 Motorized Road Grader. This manual contains instructions for Direct Support and General Support levels of maintenance and includes descriptions and functions of main units.

#### **1-2. Forms and Records**

For appropriate forms and records and their application to the Model 120 Motorized Road Grader, refer to TM 38-750.

**1-3. Equipment Serviceability Criteria**  
Refer to TM5-3805-201-ESC.

#### **1-4. Reporting of Errors**

Report of errors, omissions and recommendations for improving this publication is encouraged. Reports should be submitted on DA Form 2028, Recommended Changes to Publications, and forwarded to Commanding General, U. S. Army Mobility Equipment Command, ATTN: AM-SME-MPP, 4300 Goodfellow Blvd., St. Louis, Mo. 63120.

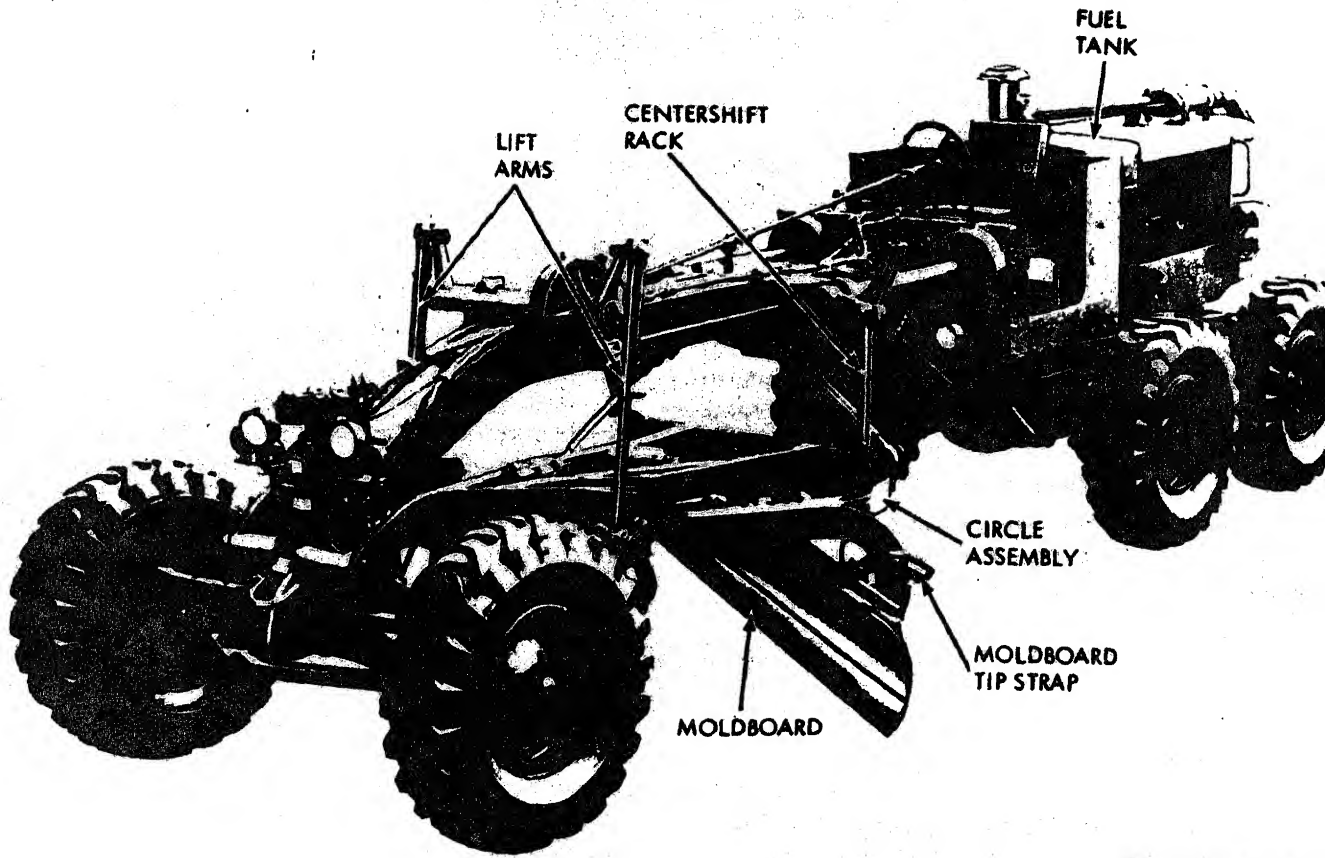
### **Section II. DESCRIPTION AND DATA**

#### **1-5. Description**

The Model 120 Motorized Road Grader (fig. 1-1 and 1-2) is a low speed grader powered by a six-cylinder diesel engine. The powershift transmission provides six forward and six reverse speeds. Power is transferred from the transmission to the tandem

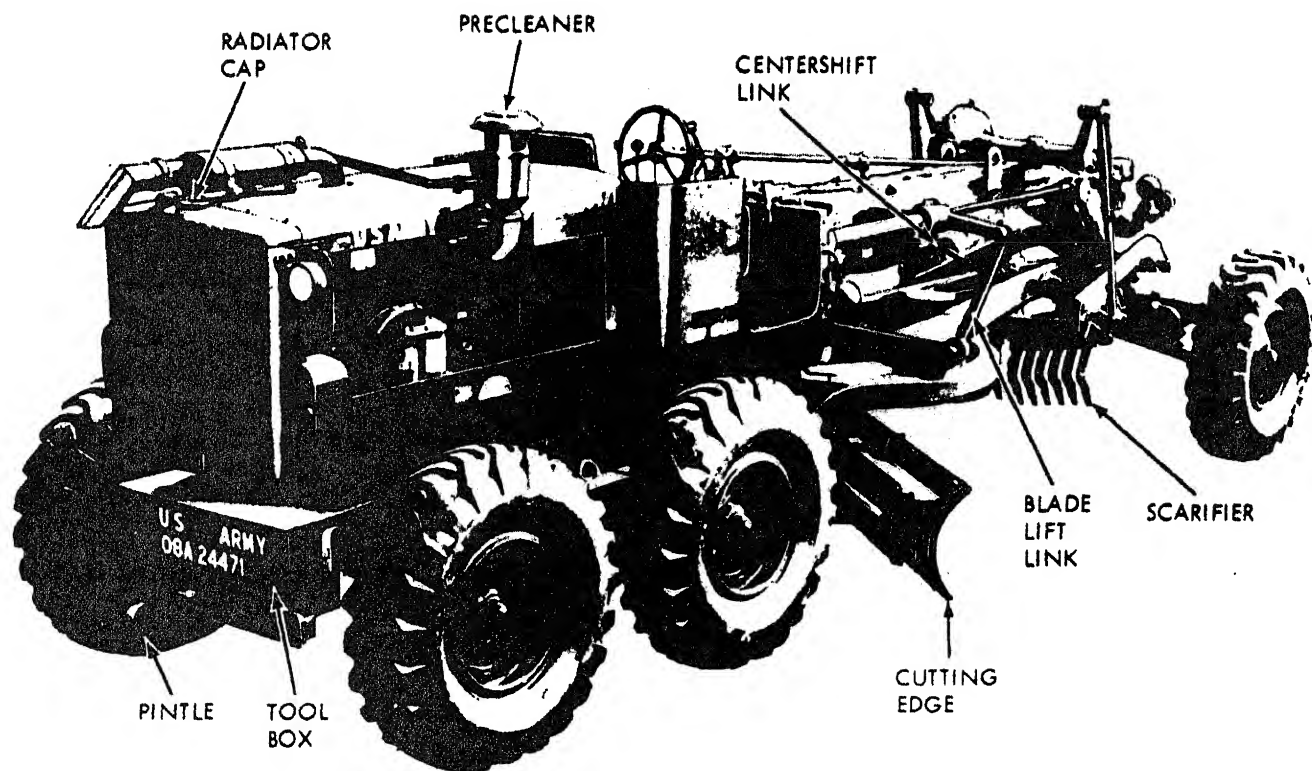
drive wheels by means of a drive chain. The steerable front wheels are equipped with a lean capability to aid in maneuvering. Steering is hydraulically controlled. The grader is equipped with a twelve-foot hydraulic sideshift blade and a scarifier.





ME 3805-249-34/1-

*Figure 1-1. Grader, left front, three quarter view.*



ME 3805-249-34/1-2

Figure 1-2. Grader, right rear, three quarter view.

## 1-6. Difference Between Models.

This manual covers only the Model 120 Road Grader. No known unit differences exist for the model.

## 1-7. Identification and Tabulated Data

a. *Identification.* The Model 120 Motorized Road Grader has ten major identification and instruction plates as follows:

(1) *Army data plate.* Located on the left exterior of the operator's compartment. Gives the model, contract, registration, and serial numbers.

(2) *Transportation data plate.* Located on the left exterior of the operator's compartment. Gives dimensions, weights, and tiedown information.

(3) *Lubrication instruction plate.* Located on the right exterior of the operator's compartment. Gives maintenance lubrication intervals, quantities and lubricants.

(4) *Warning plate.* Located on the right side of the seat. Provides safety information.

(6) *Air cleaner instruction plate.* Located on the right side of the engine compartment. Gives air cleaner service instructions.

(7) *Shifting instruction plate.* Located on the right side of the operator's compartment. Provides shifting instructions and warnings.

(8) *Transmission filter instruction plate.* Mounted on top of the transmission filter access cover. Provides service information.

(9) *Fuel filter instruction plate.* Located on the right side of the engine. Provides filter service instructions.

(10) *Direct electric starting instructions plate.* Located on the right side of the seat. Gives instructions for starting the engine.

### b. Tabulated Data.

#### (1) Overall dimensions and weights.

Length .....	322.0 inches
Width .....	96.0 inches
Height .....	95.0 inches

**Width across tires—**

front ..... 80 inches  
 rear ..... 79¼ inches

**(2) Grader.**

Manufacturer ..... Caterpillar Tractor Co.  
 Model ..... 120  
 Serial number range ..... 90R1 and subsequent  
 Axle load (front) ..... 8200 pounds  
 Axle load (rear) ..... 19600 pounds  
 Ground clearance ..... 56 inches  
 Turning radius ..... 35¾ feet

**(3) Engine.**

Manufacturer ..... Caterpillar Tractor Co.  
 Model ..... D333  
 Cycles ..... 4  
 Number of cylinders ..... 6, in-line  
 Bore ..... 4.75 inches  
 Stroke ..... 6 inches  
 Injector size ..... 9.0 millimeters  
 Displacement ..... 638 cubic inches  
 Rated power ..... 121 horsepower at 2000 rpm  
 Firing order ..... 1-5-3-6-2-4  
 Low idle speed ..... 650 rpm  
 High idle speed ..... 2140 rpm

**(4) Air cleaner.**

Manufacturer ..... Donaldson Co.  
 Part Number ..... EGB12-0076  
 Type ..... Dry air

**(5) Fuel injection pump.**

Manufacturer ..... Caterpillar Tractor Co.  
 Part Number ..... 5S9076

**(6) Fuel injection nozzle.**

Manufacturer ..... Caterpillar Tractor Co.  
 Part number ..... 8S3962

**(7) Fuel transfer pump.**

Manufacturer ..... Caterpillar Tractor Co.  
 Part number ..... 7S4430

**(8) Governor.**

Manufacturer ..... Caterpillar Tractor Co.  
 Part number ..... 5R1449

**(9) Oil pump.**

Manufacturer ..... Caterpillar Tractor Co.  
 Part number ..... 5R0439

**(10) Oil filter.**

Manufacturer ..... Caterpillar Tractor Co.  
 Part number (element) ..... MS35802-3  
 Type ..... Pleated paper

**(11) Starting motor.**

Manufacturer ..... Delco-Remy  
 Part number ..... 1113987  
 Volts ..... 24

**(12) Alternator.**

Manufacturer ..... Delco-Remy  
 Part number ..... 1117226  
 Volts ..... 24  
 Type ..... Brushless, internal regulator  
 Drive ..... Belt

**(13) Batteries.**

Quantity ..... 2  
 Size ..... 6TN  
 Volts ..... 12  
 Number of plates ..... 138  
 Manufacturer ..... Caterpillar Tractor Co.  
 Rating ..... 100 amp

Second ..... 3.67  
 Third ..... 5.81  
 Fourth ..... 7.99  
 Fifth ..... 13.92  
 Sixth ..... 22.25

**Reverse (mph)**

First ..... 2.51  
 Second ..... 4.42  
 Third ..... 6.93  
 Fourth ..... 9.65  
 Fifth ..... 16.70  
 Sixth ..... 26.30

**(15) Clutch.**

Manufacturer ..... Caterpillar Tractor Co.  
 Part number ..... 5D9650  
 Type ..... Flywheel

**(16) Service brake.**

Manufacturer ..... Wagner Electric Corp.  
 Part number ..... FF-51100 / FF-51101  
 Type ..... Hydraulic

**(17) Hydraulic pump.**

Manufacturer ..... Vickers  
 Part number ..... V200-8-OD-12-S / 48  
 Type ..... Vane  
 Rated output ..... 8.2 gpm at 1200 rpm and 0 psi

**(18) Hydraulic control valve.**

Manufacturer ..... Rivinius, Inc.  
 Part number ..... A7041

**(19) Hydraulic cylinder.**

Manufacturer ..... Rivinius, Inc.  
 Part number ..... A948  
 Type ..... Double acting

**(20) Steering gear.**

Manufacturer ..... Ross Gear and Tool Co.  
 Part number ..... HPS71397  
 Type ..... Hydraulic / mechanical

**(21) Tires.**

Quantity ..... 6  
 Make ..... Caterpillar Tractor Co.  
 Size ..... 13.00 x 24 inches  
 Road range ..... E  
 Type ..... Tubeless  
 Tread type ..... G2  
 Inflation ..... 35 psi  
 Rating speed ..... 10 mph

**(22) Capacities.**

Crankcase ..... 7.25 gallons  
 Fuel tank ..... 75 gallons  
 Cooling system ..... 11 gallons  
 Transmission ..... 20 gallons  
 Rear axle housing ..... 9.25 gallons  
 Tandem drive housing ..... 6 gallons  
 Hydraulic system ..... 4.5 gallons  
 Power control worm  
 and gear housing ..... 0.5 gallons  
 Power control housing ..... 2 gallons  
 Blade lift drive  
 housing ..... 1 gallon  
 Circle reverse control  
 housing ..... 2.5 quarts  
 Transfer gear housing ..... 0.7 pint  
 Circle centershift control  
 housing ..... 1 quart

## Special Torques

<i>Fastener</i>	<i>Torque (ft lbs)</i>
Camshaft retaining nut .....	190-210
Crankshaft pulley retaining bolt.....	200-220
Cylinder head bolts .....	170-180
Engine support bolt .....	130-170
Flywheel retaining bolt.....	130-170
Flywheel housing retaining bolt.....	65-85
Engine oil pump retaining nut .....	60
Glow plugs.....	10-12
Rocker arm cover retaining bolt.....	6-10
Rocker arm shaft retaining bolt.....	95-125
Timing gear housing retaining bolt.....	27-37
Water pump adapter retaining nut.....	85-95
Transmission oil pump studs.....	17-23
Hydraulic pump cover bolt .....	65-75
Steering arm-to-pitman shaft retaining nut.....	300-340
Bevel gear retaining nut.....	210-250
Brake anchor pin locknut .....	300-350
Sprocket-to-axle shaft retaining nut.....	400-450
Wheel-to-spindle retaining nut.....	300-350
Power control drive shaft-to-flange bolt.....	13-23
Blade lift housing retaining nut.....	80-90
Blade lift housing retaining bolt.....	160-200
Bevel gear-to-worm shaft retaining nut.....	275-310

## General Torques

### Bolts and Nuts

<i>Size (inches)</i>	<i>Torque (ft lbs)</i>	<i>Size (inches)</i>	<i>Torque (ft lbs)</i>
1 / 4	9±3	3 / 4	265±35
5 / 16	18±5	7 / 8	420±60
3 / 8	32±5	1	640±80
7 / 16	50±10	1 1 / 8	800±100

<i>Size (inches)</i>	<i>Torque (ft lbs)</i>	<i>Size (inches)</i>	<i>Torque (ft lbs)</i>
1 / 2	75±10	1 1 / 4	1000±120
9 / 16	110±15	1 3 / 8	1200±150
5 / 8	150±20	1 1 / 2	1500±200

### Taperlock Studs

<i>Size (inches)</i>	<i>Torque (ft lbs)</i>	<i>Size (inches)</i>	<i>Torque (ft lbs)</i>
1 / 4	5±2	3 / 4	110±15
5 / 16	10±3	7 / 8	170±20
3 / 8	20±3	1	260±30
7 / 16	30±5	1 1 / 8	320±30
1 / 2	40±5	1 1 / 4	400±40
9 / 16	60±10	1 3 / 8	480±40
5 / 8	75±10	1 1 / 2	550±50

### Hydraulic Valve Bolts and Nuts

<i>Size (inches)</i>	<i>Torque (ft lbs)</i>	<i>Size (inches)</i>	<i>Torque (ft lbs)</i>
5 / 16	15±2	1 / 2	65±5
3 / 8	27±3	5 / 8	130±12
7 / 16	43±4		

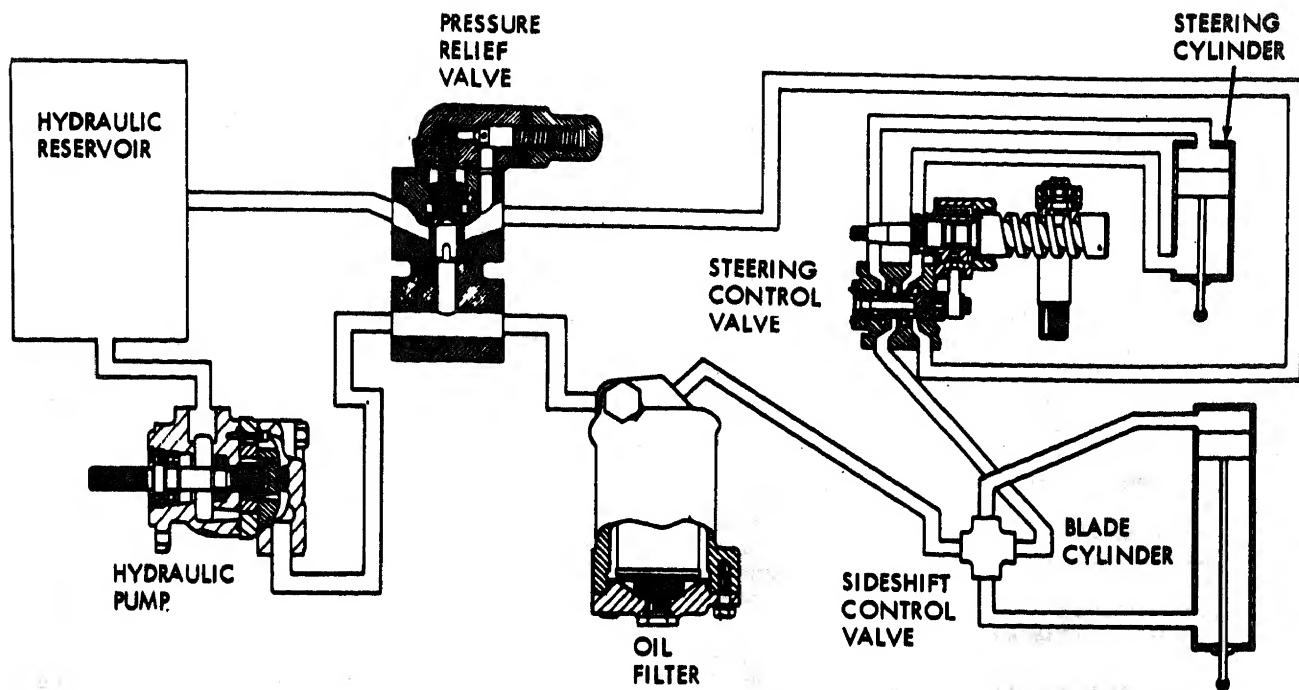
*Note.* These values apply to fasteners as received from the supplier, dry, or when lubricated with engine oil. They do not apply if special graphited or molybdenum disulfide greases or other extreme pressure lubricants are used.

(24) *Wiring diagram.* See figure 1-3. (located in back of manual).

(25) *Hydraulic diagram.* See figure 1-4.

*Figure 1-3. Electrical diagram.*

(Located in back of manual.)



ME 3805-249-34/1-4

Figure 1-4. Hydraulic diagram.

## CHAPTER 2

# DIRECT AND GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

### Section I. REPAIR PARTS, SPECIAL TOOLS AND EQUIPMENT

#### 2-1. Special Tools and Equipment

There are no special tools and equipment required to perform maintenance on the Model 120 Motorized Road Grader are listed in table 2-1. The tools and fixtures listed in table 2-1 are not essential to perform maintenance or repairs on the Model 120 Motorized Road Grader. The illustrations with

dimensions may be used to fabricate these items if repair facilities desire. Most mechanics fabricate this type of items when the need arises; therefore, the dimensions shown are helpful. References and illustrations indicating the use of these items are listed in the table.

*Table 2-1. Special Tools and Equipment*

Item	Reference		Use
	Figure (fabricated items)	Paragraph	
Master link tool	2-1	4-14	Remove and install all tandem drive chain master link
Bearing removal and installation tool	2-2	3-21	Remove and install main bearings
Transmission stabilizer bar	2-3	2-8	Remove transmission and tandem drives

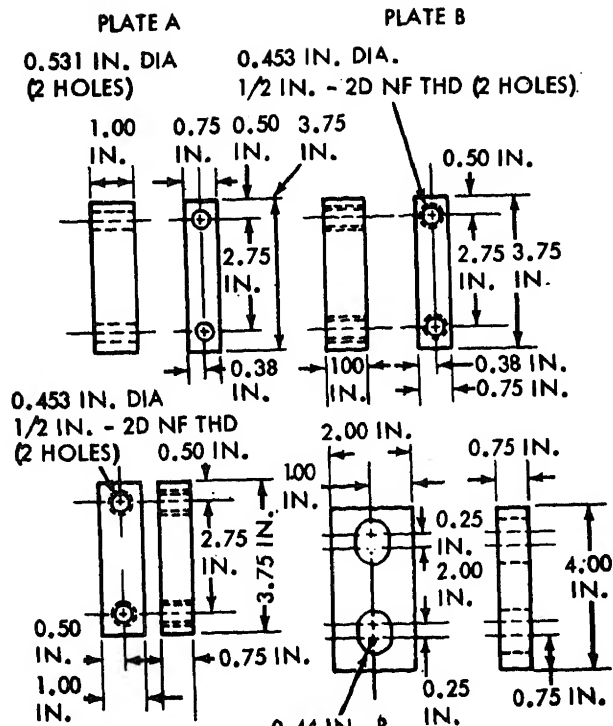
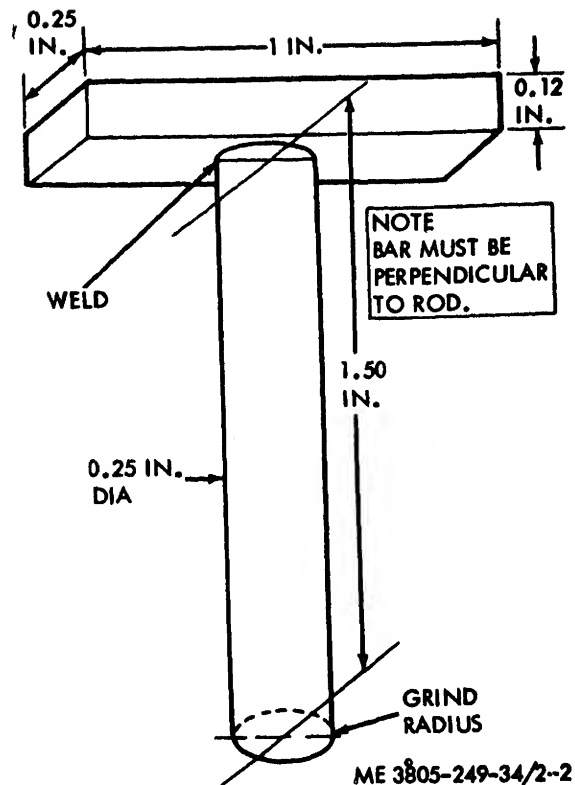


PLATE C

PLATE D

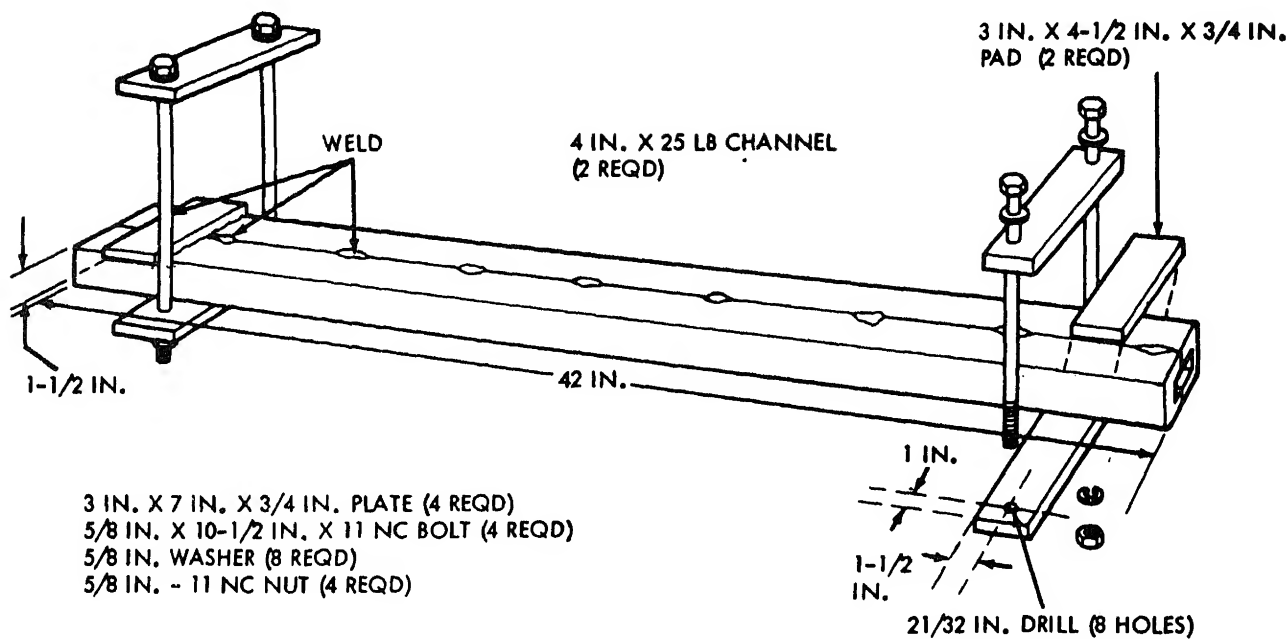
ME 3805-249-34/2-1



ME 3805-249-34/2-2

Figure 2-1. Master link tool.

Figure 2-2. Bearing removal and installation tool.



**2-2. Maintenance Repair Parts**  
Maintenance repair parts and equipment for Direct

Support and General Support Maintenance are listed and illustrated in TM5-3805-249-35P.

## Section II. TROUBLESHOOTING

### 2-3. General

This section provides information for diagnosing and correcting improper operation or failure of the grader components. Each symptom in table 2-2 is

followed by a list of probable causes and possible remedies.

### 2-4. Troubleshooting

Refer to table 2-2 for troubleshooting information.

*Table 2-2. Troubleshooting*

Malfunction	Probable cause	Corrective action
1. Engine does not turn over.	a. Defective Heat / Start switch. b. Defective batteries c. Defective starter.	a. Replace switch (fig. 1-3). b. Charge or replace (TM5-3805-249-12). c. Replace brushes or replace starter (para 3-11).
2. Engine turns over but does not start.	a. No fuel to engine. b. Defective fuel transfer pump. c. Fuel injection drive is slipping. d. Engine improperly timed.	a. Check for empty fuel tank, plugged lines, clogged filters, air in fuel system. b. Repair pump (para 3-8). c. Tighten the accessory drive gear retaining nut. d. Time the accessory drive shaft (para 3-9).
3. Engine hard to start.	a. Insufficient fuel. b. Clogged fuel filter. c. Defective fuel injection nozzle. d. Insufficient air to engine. e. Fuel injection pump defective or improperly timed. f. Valves defective or improperly adjusted.	a. Check and replenish. b. Service the filter (TM5-3805-249-12). c. Repair or replace (para 3-5). d. Service air cleaner (TM5-3805-249-12). e. Check timing or repair pump if necessary (para 3-6). f. Adjust valve lash (TM5-3805-249-12) or replace (para 3-19).
4. Engine misfires.	a. Defective fuel injection nozzle or pump. b. Improper valve lash. c. Incorrect fuel injection timing. d. Low fuel supply pressure. e. Defective high pressure fuel line. f. Air in fuel system. g. Bent or broken push rod.	a. Check fuel system and correct. b. Adjust valves (TM5-3805-149-12). c. Check timing (para 3-6). d. Check lines for leaks or obstructions. Service filter. Check for defective transfer pump (para 3-8). e. Replace the line. f. Locate source of air entry and correct. Bleed system (TM5-3805-249-12). g. Replace push rod (para 3-19).
5. Engine stalls at low	a. Idle speed setting too low. b. Low fuel supply pressure. c. Defective fuel injection nozzle.	a. Adjust the governor (para 3-7). b. Check lines for leaks or obstructions. Service filter. Check for defective transfer pump. c. Repair or replace nozzle (para 3-5).
6. Engine speed erratic.	Defective governor.	Check for proper installation. Repair governor (para 3-7).
7. Low engine power.	a. Defective fuel injection nozzle.	a. Repair or replace nozzle (para



Malfunction	Probable cause	Corrective action
8. Engine vibrates	<p>d. Improper fuel injection timing.</p> <p>e. Excessive valve lash.</p> <p>f. Low fuel supply pressure.</p> <p>g. Governor control linkage defective.</p> <p>a. Loose or defective engine mounts.</p> <p>b. Loose pulley and damper.</p> <p>c. Misfiring.</p> <p>d. Unbalanced fan blade.</p> <p>e. Valves burned or damaged.</p>	<p>d. Time pump (para 3-6).</p> <p>e. Adjust valves (TM5-3805-249-12).</p> <p>f. Check lines for leaks or obstructions. Service filter. Check for defective transfer pump.</p> <p>g. Replace damaged components. Check for proper adjustment.</p> <p>a. Tighten mounting bolts securely. Replace defective mounts.</p> <p>b. Retighten.</p> <p>c. Refer to trouble 4.</p> <p>d. Remove fan belts and see if vibration still exists. If not, replace the fan (TM5-3805-249-12).</p> <p>e. Replace or replace valves (para 3-19).</p> <p>a. Repair or replace (para 3-6).</p>
9. Heavy combustion knock.	<p>a. Defective fuel injection pump plunger and barrel assembly.</p> <p>b. Defective fuel injection nozzle.</p>	<p>b. Repair or replace (para 3-5).</p>
10. Valves make clicking noise.	<p>a. Excessive valve lash.</p> <p>b. Broken valve spring.</p> <p>c. Insufficient lubrication.</p>	<p>a. Adjust (TM5-3805-249-12).</p> <p>b. Replace (para 3-19). Check for other damage.</p> <p>c. Check for oil passage restrictions. Clean passages.</p>
11. Oil in coolant.	<p>a. Defective cylinder head gasket.</p> <p>b. Defective oil cooler core.</p>	<p>a. Replace gasket (para 3-19).</p> <p>b. Replace</p>
12. Engine knocks.	<p>a. Defective connecting rod bearing.</p> <p>b. Defective timing gear train.</p> <p>c. Broken crankshaft.</p>	<p>a. Replace (para 3-20). Check the connecting rod and crankshaft. Replace if necessary.</p> <p>b. Repair or replace components as required (para 3-18).</p> <p>c. Replace crankshaft (para 3-21).</p>
13. Excessive fuel consumption.	<p>a. Leaks in fuel system.</p> <p>b. Fuel and combustion knock.</p>	<p>a. Repair.</p> <p>b. Refer to troubles 4 and 7.</p>
14. Loud valve train noise.	<p>a. Broken camshaft.</p> <p>b. Defective valve lifters.</p>	<p>a. Replace defective parts (para 3-22). Clean engine thoroughly.</p> <p>b. Replace camshaft and valve lifters (para 3-22). Clean engine. Adjust valve lash (TM5-3805-249-12).</p>
15. Little rocker arm movement and excessive valve lash.	<p>a. Worn cam lobes.</p> <p>b. Broken or worn valve lifters.</p> <p>c. Worn valve tips.</p> <p>d. Worn valve lifter face.</p> <p>e. Worn push rods.</p> <p>f. Worn rocker arms.</p>	<p>a. Check and adjust valve lash (TM5-3805-249-12). Replace camshaft if damaged (para 3-22). Clean engine.</p> <p>b. Replace lifters (para 3-19). Check camshaft for wear. Check for sticking valves and bent shims. Clean engine.</p> <p>c. Adjust valve lash (TM5-3805-249-12). If wear is excessive, replace valve (para 3-19).</p> <p>d. Adjust valve lash (TM5-3805-249-12). If wear is excessive, replace lifters (para 3-19).</p> <p>e. Adjust valve lash (TM5-3805-249-12). If wear is excessive, replace push rods (para 3-19).</p> <p>f. Adjust valve lash (TM5-3805-249-12). If wear is excessive, replace rocker arms (para 3-19).</p>

17. Coolant in engine lubricating oil.

18. Excessive black or gray smoke in exhaust.

19. Excessive white or blue smoke in exhaust.

20. Low engine oil pressure.

21. High lubricating oil consumption.

22. Engine slobbers.

23. Abnormal engine coolant temperature.

- a. Defective cylinder head gasket.  
b. Cracked or defective cylinder head.  
c. Cracked or defective cylinder block.  
d. Defective oil cooler core.  
e. Insufficient air to cylinders.

- b. Fuel injection nozzle plugged or leaking.  
c. Incorrect fuel injection timing.

- a. Worn valve guides  
b. Worn piston rings.  
c. Crankcase oil level too high.  
d. Engine is misfiring.  
e. Incorrect fuel injection timing.

- a. Engine oil diluted with fuel.  
b. Excessive crankshaft bearing clearances.  
c. Excessive camshaft bearing clearances.  
d. Worn rocker arm.  
e. Excessive timing gear bearings clearance.  
f. Defective oil pump.  
g. Defective suction bell.  
h. Clogged oil filter or cooler.

- a. External oil leaks.  
b. Excessive oil to intake valve guides.  
c. Excessive valve guide wear.  
d. Crankcase oil level too high.  
e. High oil temperature.  
f. Worn piston rings or liners.

- a. Worn valve guides.  
b. Excessive lubricating oil in valve compartment.  
c. Worn piston rings or liners.

- a. Combustion gases in coolant.  
b. Defective water thermostat  
c. Defective temperature gage.  
d. Coolant level low.  
e. Radiator passages restricted.  
f. Defective water pump.  
g. Incorrect fuel injection timing.

entry. Service filter. Change oil (TM5-3805-249-12).

- a. Replace gasket (para 3-19).  
b. Replace cylinder head (para 3-19).  
c. Replace cylinder block (para 3-23).  
d. Replace oil cooler core (para 4-6).  
e. Service air cleaner (TM5-3805-249-12). Check for restricted air passages.

- b. Repair or replace nozzle (para 3-5).  
c. Check and adjust timing (para 3-6).

a. Recondition cylinder head (para 3-19).

- b. Replace rings (para 3-20).  
c. Avoid overfilling. Drain excess oil.  
d. Refer to trouble 4.  
e. Check and adjust timing (para 3-6).

a. Check seals on transfer pump drive shaft. Drain and refill crankcase (TM5-3805-249-12).

b. Replace crankshaft or bearings (para 3-21). Service filter (TM5-3805-249-12).

c. Replace bearings or camshaft (para 3-22).

d. Check lubrication. Replace parts as required (para 3-19).

e. Inspect bearings. Replace parts as necessary (para 3-18).

f. Repair or replace (para 3-14).

g. Replace (para 3-14).

h. Service filter (TM5-3805-249-12). Repair cooler as required (para 4-6).

a. Locate leaks and repair.

b. Refer to trouble 22.

c. Refer to trouble 22.

d. Avoid overfilling. Drain excess oil.

e. Repair oil cooler (para 4-6).

f. Replace components as necessary (para 3-20).

a. Recondition cylinder head (para 3-19).

b. Ensure that rocker arms are properly installed (para 3-19).

c. Replace components as necessary (para 3-20).

a. Determine entry point of gases. Repair or replace component as required.

b. Test thermostat defective (TM5-3805-249-12).

c. Replace gage. (fig. 2-9, TM5-3805-249-12)

d. Add coolant (TM5-3805-249-12).

e. Clean core (para 3-2).

f. Repair or replace as required (para 3-3).

g. Check and adjust timing (para 3-6)

24. Transmission does not operate or slips.	<ul style="list-style-type: none"> <li>h. Slipping transmission clutches.</li> <li>a. Low oil pressure.</li> <li>b. Defective transmission.</li> <li>c. Flywheel clutch slips.</li> <li>d. Defective transfer gear.</li> <li>e. Defective bevel pinion or bevel gear.</li> </ul>	<ul style="list-style-type: none"> <li>h. Refer to trouble 26.</li> <li>a. Refer to trouble 25.</li> <li>b. Disassemble and locate defect. Repair (para 4-5).</li> <li>c. Check and repair (para 4-2).</li> <li>d. Check and repair (para 4-8).</li> <li>e. Check and repair (para 4-8).</li> </ul>
25. Transmission oil pressure low.	<ul style="list-style-type: none"> <li>a. Low oil level.</li> <li>b. Control linkage improperly adjusted.</li> <li>c. Defective oil pump.</li> <li>d. Leakage within transmission.</li> </ul>	<ul style="list-style-type: none"> <li>a. Check and replenish (TM5-3805-249-12).</li> <li>b. Check and adjust (TM5-3805-249-12).</li> <li>c. Repair (para 4-3).</li> <li>d. Locate leaks and correct (para 4-5).</li> </ul>
26. Transmission overheats.	<ul style="list-style-type: none"> <li>a. Faulty temperature gage.</li> <li>b. Oil level low.</li> <li>c. Defective oil cooler.</li> <li>d. Excessive clutch drag.</li> <li>e. Defective oil pump.</li> <li>f. Flywheel clutch slips.</li> </ul>	<ul style="list-style-type: none"> <li>a. Check and replace.</li> <li>b. Check and replenish (TM5-3805-249-12).</li> <li>c. Repair or replace (para 4-6).</li> <li>d. Check and adjust (para 4-2).</li> <li>e. Replace or repair (para 4-3).</li> <li>f. Check and repair (para 4-2).</li> </ul>
27. Transmission does not shift.	<ul style="list-style-type: none"> <li>a. Low oil level.</li> <li>b. Low clutch pressures.</li> <li>c. Defective shift linkage.</li> <li>d. Defective oil pump.</li> <li>e. Defective hydraulic control.</li> </ul>	<ul style="list-style-type: none"> <li>a. Check and replenish (TM5-3805-249-12).</li> <li>b. Repair or replace defective components (para 4-2).</li> <li>c. Check adjustment. Replace defective parts (TM5-3805-249-12).</li> <li>d. Replace or repair (para 4-3).</li> <li>e. Replace or repair (para 4-4).</li> </ul>
28. Shifting is sulkyish.	<ul style="list-style-type: none"> <li>a. Low oil pressure.</li> <li>b. Low clutch pressure.</li> </ul>	<ul style="list-style-type: none"> <li>a. Refer to trouble 25.</li> <li>b. Repair or replace defective components (para 4-2).</li> </ul>
29. Transmission pump is noisy.	Pump is cavitated.	Disassemble and replace defective parts (para 4-3).
30. Transmission operates in forward only.	<ul style="list-style-type: none"> <li>a. Worn discs and plates, leaking seals or broken components in No. 2 clutch.</li> <li>b. Defective shift linkage.</li> </ul>	<ul style="list-style-type: none"> <li>a. Locate and replace defective components (para 4-5).</li> <li>b. Check adjustment. Replace defective components (TM5-3805-249-12).</li> </ul>
31. Transmission operates in reverse only.	<ul style="list-style-type: none"> <li>a. Worn discs and plates, leaking seals or broken components in No. 1 clutch.</li> <li>b. Defective shift linkage.</li> </ul>	<ul style="list-style-type: none"> <li>a. Locate and replace defective components (para 4-5).</li> <li>b. Check adjustment. Replace defective components (TM5-3805-249-12).</li> </ul>
32. Starter does not crank the engine.	<ul style="list-style-type: none"> <li>a. Defective batteries.</li> <li>b. Loose connections.</li> <li>c. Defective starter.</li> </ul>	<ul style="list-style-type: none"> <li>a. Charge or replace batteries (TM5-3805-249-12).</li> <li>b. Check for corroded terminals. Tighten connections.</li> <li>c. Replace brushes or replace starter (para 3-11).</li> </ul>
33. Electrical system not providing power.	<ul style="list-style-type: none"> <li>a. Defective batteries.</li> <li>b. Loose, corroded or defective cables.</li> <li>c. Defective alternator.</li> </ul>	<ul style="list-style-type: none"> <li>a. Charge or replace batteries (TM5-3805-249-12).</li> <li>b. Clean terminals. Tighten cables. Replace defective cables.</li> <li>c. Replace alternator (TM5-3805-249-12).</li> </ul>
34. Hydraulic pump is noisy.	<ul style="list-style-type: none"> <li>a. Air leak at inlet port.</li> <li>b. Worn pump.</li> <li>c. Low pressure relief valve setting.</li> <li>d. Incorrect oil in system.</li> </ul>	<ul style="list-style-type: none"> <li>a. Repair.</li> <li>b. Disassemble and replace worn components (para 8-6).</li> <li>c. Repair or replace valve (para 8-7).</li> <li>d. Drain oil and service with correct grade (TM5-3805-249-12).</li> </ul>

Malfunction	Probable Cause	Corrective Action
35. Hydraulic pump does not deliver sufficient oil.	a. Low oil level. b. Defective pump. c. Slow engine speed.	a. Check and replenish. b. Repair or replace (para 8-6). c. Check and adjust governor (para 3-7).
36. Hydraulic cylinder moves slowly.	a. Defective pump. b. Low pressure relief valve setting. c. Defective cylinder packings	a. Replace or repair (para 8-6). b. Replace or repair (para 8-7). c. Disassemble cylinder and replace defective parts (para 8-10).
37. Steering jerky or erratic.	a. Steering control sticks.	a. Check for defective steering gear components and replace (para 8-2). Lubricate valve.
38. Wheel brakes do not operate properly.	b. Excessive steering gear backlash. a. Insufficient fluid in master cylinder. b. Brakes not properly adjusted.	b. Adjust (para 8-2). a. Check and replenish (TM5-3805-249-12). b. Adjust brakes (TM5-3805-249-12).
39. Parking brake does not hold.	c. Leaky or defective brake lines. d. Defective master cylinder. e. Defective brake. a. Linkage or lever out of adjustment. b. Defective parking brake clutches.	c. Tighten connections. Replace defective lines. d. Repair (para 4-15). e. Repair (para 4-16). a. Check and adjust (TM5-3805-249-12). b. Locate and replace or repair defective components (para 4-8).

### Section III. GENERAL MAINTENANCE

#### 2-5. General

This section contains general maintenance information that would otherwise have to be repeated throughout this manual.

#### 2-6. Maintenance

a. *Hardware and Threaded Parts.* Inspect hardware for damaged threads, rounded corners and damaged slots. Threaded holes and parts should accept their mating parts without requiring excessive torque. Threads may be chased with a tap or die. Replace any threaded parts which cannot be repaired.

b. *Gaskets.* Replace all gaskets which are disturbed during repair operations or which show signs of leakage. Use grease or gasket cement to hold the gasket in position during installation.

c. *Oil Seals and Packings.* Thoroughly lubricate the sealing lip of spring-loaded seals when installing. Apply a non-hardening sealant to the out circumference of encased seals or to the mating bores to prevent leakage. Immerse preformed packings in the fluid which they will contact.

d. *Ball and Roller Bearings.* After removing antifriction bearings, cover them immediately to keep out dirt and abrasives. Flush thoroughly with

bearings that are scored, pitted, discolored from overheating, or otherwise damaged. When installing bearings against shoulders, be sure the chamfered side is toward the shoulder. Lubricate the bearing and its mating surface when pressing. Press the bearing only on the race adjacent to the mating part. Use drivers which contact as much of the race as possible.

e. *Repair of Damaged Machined and Polished Surfaces.* Remove rough spots, scores, burrs, galling, gouges and other surface damage from machined and polished surfaces. Use a honing stone, crocus or emery cloth, file or other abrasive. The finish of the part must approximate that of a new part. Critical dimensions must not be altered beyond acceptable limits. Build up shafts, rods and other worn parts by neutralizing, chrome plating, or welding. Grind to the original size.

f. *Welding.* Welding must be performed by a qualified welder. Ensure that welds provide complete fusion and penetration and comply with governing specifications. Inspect all welds using a radiographic or magnetic particle technique. Grind all new welds flat and smooth whenever possible.

g. *Part Replacement.* Replace parts which are

## Section IV. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS.

### 2-7. Engine

#### a. Removal.

- (1) Close the fuel shutoff valve at the fuel tank.
- (2) Drain the oil from the flywheel housing and the engine crankcase.
- (3) Drain the cooling system.
- (4) Remove the exhaust pipe and muffler, air cleaner precleaner, fuel tank, radiator, hood and side panels. Refer to TM5-3805-249-12 for removal instructions.
- (5) Tag and disconnect the following wiring:
  - (a) Battery cables.
  - (b) Wiring to the slave receptacle.
  - (c) Wiring to the vehicle rear lights.
  - (d) The alternator output cable.
  - (e) Vehicle rear harness from the front harness.
  - (f) Starter ground cable.
- (6) Remove the fuel supply line. Cap openings.
- (7) Disconnect lines to the oil pressure gage and fuel level gage. Cap openings.
- (8) Disconnect the governor control linkage at the fuel pump.
- (9) Install two  $\frac{3}{4}$  in. -10NC forged eyebolts with suitable spacers and washers into the cylinder head.
- (10) Attach a lifting beam with chains to the two eyebolts to support the engine. The engine weighs approximately 3300 pounds.

(11) Remove the bolts and lockwashers which secure the transmission housing to the flywheel housing, and the engine front support to the frame.

(12) Lift the engine and move it to the rear until the power control drive shaft clears the flywheel clutch.

*Note.* Tag the shims located under each side of the front support to ensure installation in the same positions.

(13) Remove the engine.

#### b. Installation.

- (1) Install the engine in the reverse order of removal. Tighten all bolts securely.
- (2) Service the crankcase, cooling system and fuel tank.

### 2-8. Transmission and Tandem Drives

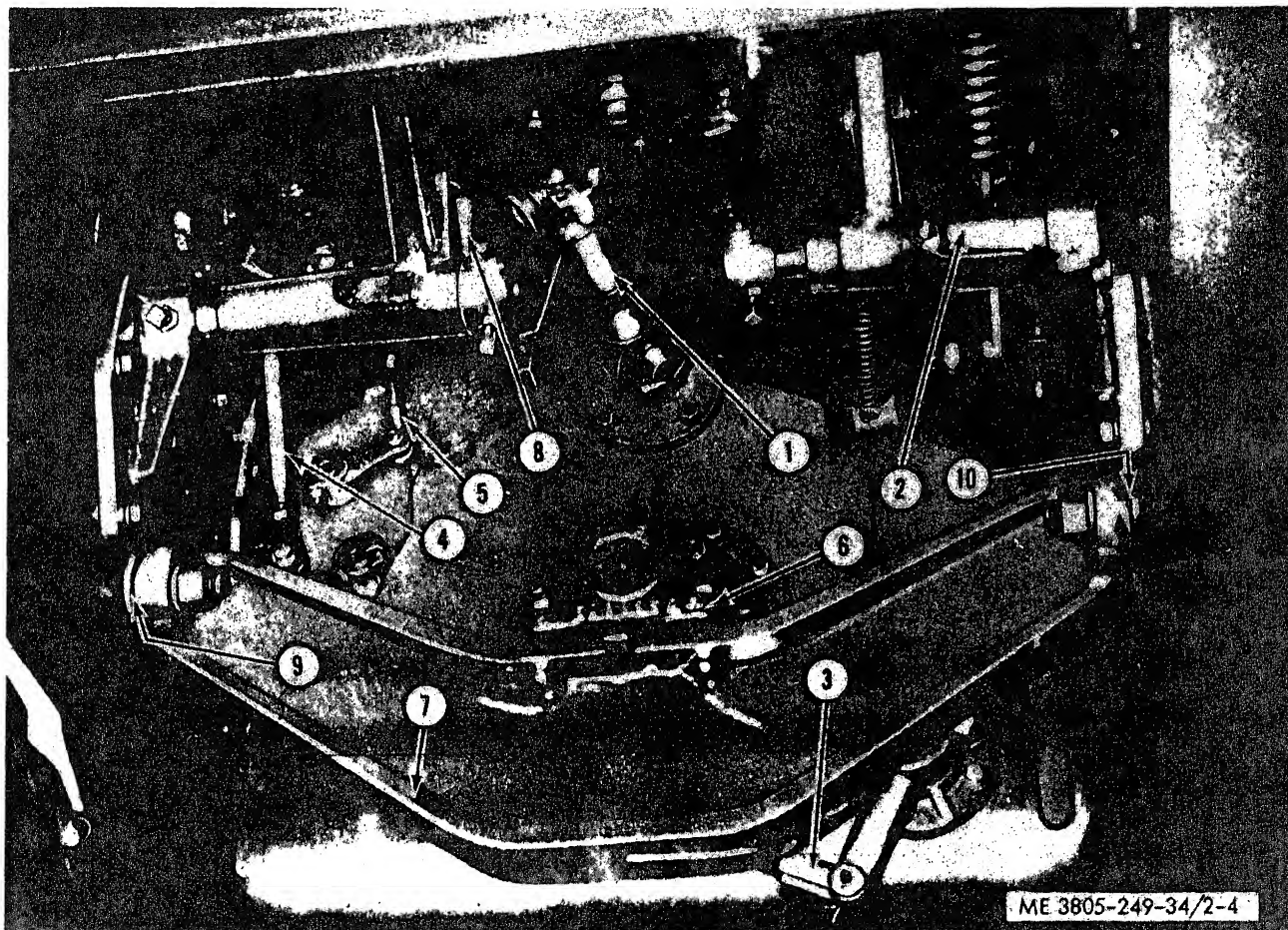
#### a. Removal.

(1) Position the blade at a 90 degree angle with the grader. Remove the pins from the blade lift links and centershift control links.

(2) Remove the engine. Refer to paragraph 2-7.

(3) Disconnect the transmission breather line.

(4) Refer to figure 2-4. Disconnect the drive shaft (1), clutch linkage (2) and parking brake linkage (3). Remove the control rod (4), shift rod (5), bracket (6), support (7) and spring (8). Remove and tag the shims (9 and 10) mounted with the support (7) and bracket (6).



1. Drive shaft
2. Clutch linkage
3. Parking brake linkage
4. Control rod
5. Shift rod

6. Bracket
7. Support
8. Spring
9. Shims
10. Shims

*Figure 2-4. Preparing to remove transmission and tandem drives.*

(5) Place a wedge on each side of the bolster between the bolster stop and front axle. Refer to figure 2-5.





Figure 2-5. Blocking the bolster.

(6) Fabricate the stabilizer bar shown in figure 2-3. Position the stabilizer bar under the tandem stops and tighten in position.

*Note.* Install approximately  $1\frac{1}{2}$  inches of blocking between the bottom clamp on the stabilizer bar and the stabilizer bar. Install  $\frac{3}{4}$  inch of blocking between the top of the stabilizer bar and the bottom of the transmission case.

(7) Disconnect the brake oil lines.

(8) Using suitable lifting equipment, raise the grader frame high enough to clear the axle housings. Roll out the transmission and tandem drives. Lower the frame, and support the frame with blocks or floor stands.

*b. Installation.* Install the transmission and tandem drives in the reverse order of removal.

## 2-9. Transmission

### a. Removal.

(1) Drain the oil from the transmission and transfer gear housing. Refer to TM5-3805-249-12.

(2) Remove the seat (para 9-2).

(3) Lift the battery cover and disconnect and remove the batteries. Refer to TM5-3805-249-12. Remove four bolts and remove the battery box.

(4) Remove the two lift floor plates. Refer to TM5-3805-249-12.

(5) Refer to figure 2-6. Disconnect the brake return spring. Remove the seat support.

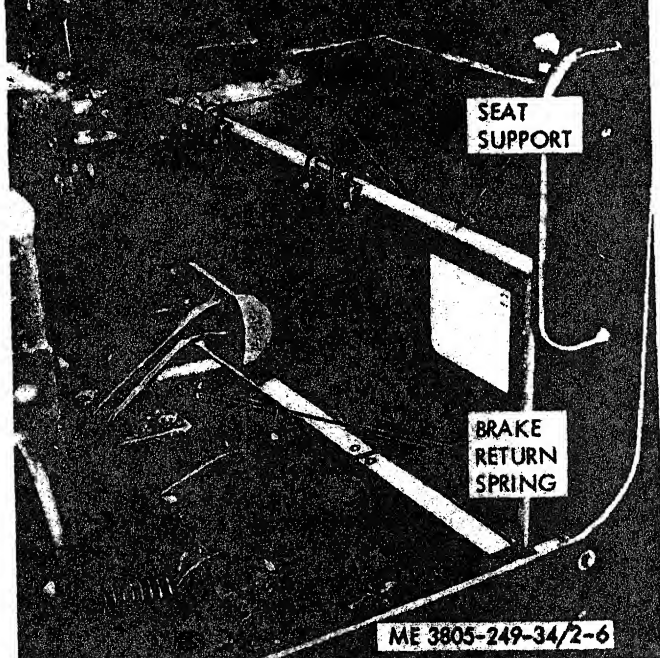


Figure 2-6. Brake return spring and seat support.

(6) Remove the clutch pedal and linkage. Refer to TM5-3805-249-12.

(7) Remove the power control drive shaft and universal joints. Refer to TM5-3805-249-12.

(8) Refer to figure 2-7. Remove the governor control rod and disconnect the governor control linkage from the accelerator pedal. Remove the right floor plate and the accelerator pedal as a unit. Remove the transmission shift lever housing side plate.

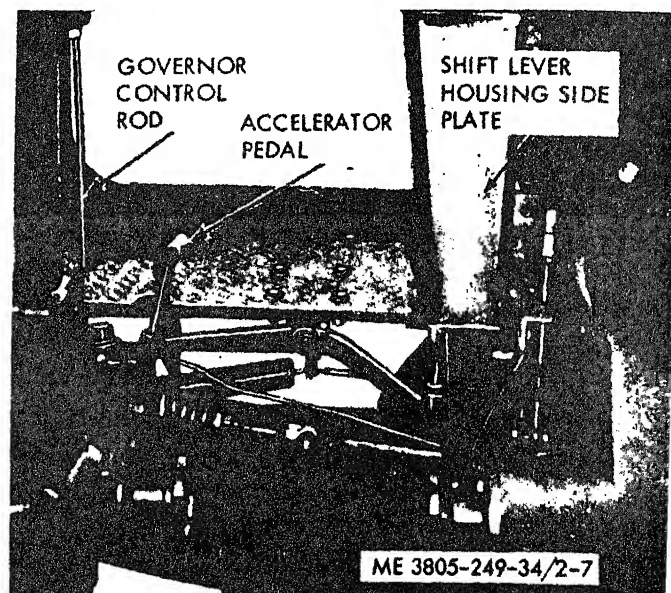
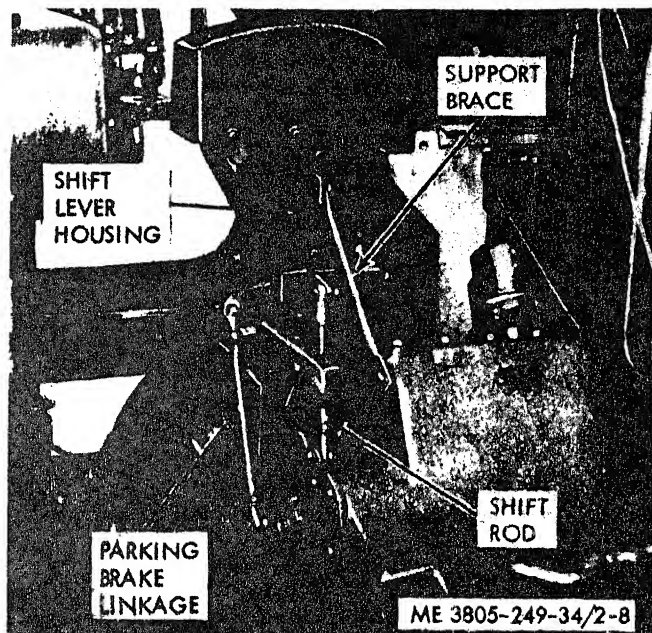


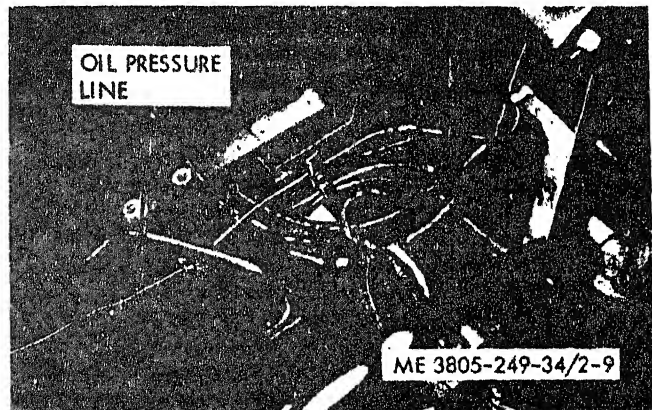
Figure 2-7. Removing floor plates.

(9) Refer to figure 2-8. Disconnect the shift rod, parking brake linkage and transmission support brace. Remove the shift lever housing.



*Figure 2-8. Removing transmission controls.*

(10) Remove the transmission oil pressure line (fig. 2-9) from the oil filter and transmission. Cap or plug openings.



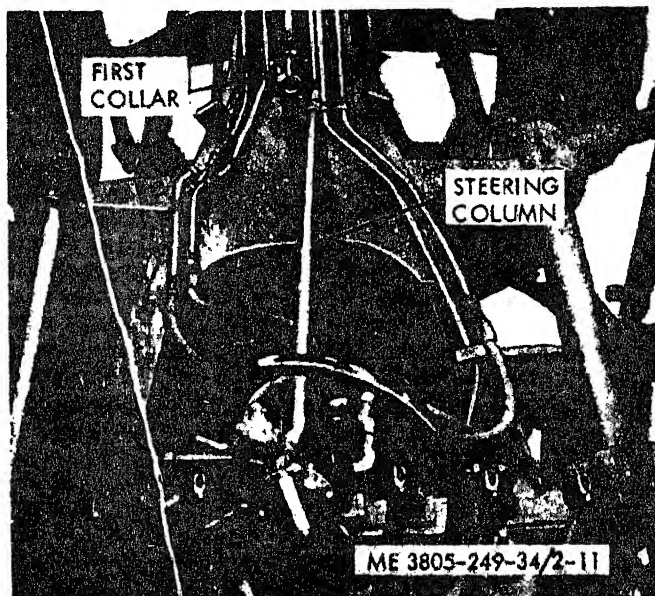
*Figure 2-9. Removing oil pressure line.*

(11) Remove the right engine side panel and disconnect the two transmission oil cooler lines (fig. 2-10) at the transmission. Cap or plug openings.



*Figure 2-10. Removing oil cooler lines.*

(12) Disconnect the steering wheel column at the first collar (fig. 2-11) and slide the steering wheel assembly forward.



*Figure 2-11. Disconnecting the steering column.*



(13) Install three 3/4 in. -10NC forged eyebolts and attach a suitable hoist to the transmission. Refer to figure 2-12.

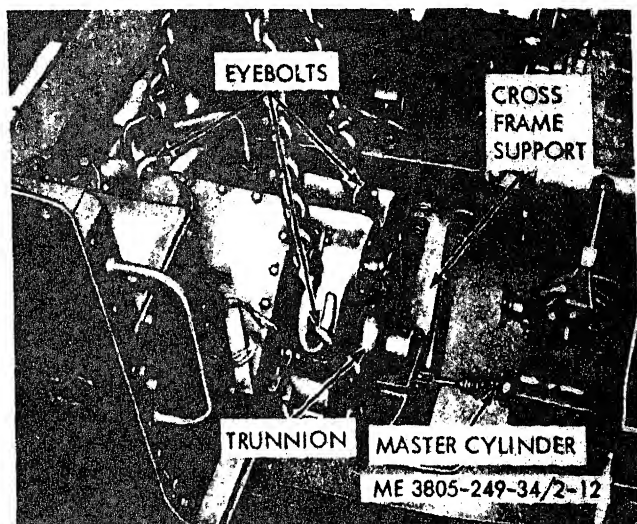


Figure 2-12. Attaching the hoist.

(14) Place blocks under the transfer gear housing to support the weight of the housing.

(15) Remove the cross frame support at the front of the transmission (fig. 2-12). Remove the trunnion from the transmission housing. Disconnect the brake master cylinder and tie to the frame to allow clearance for the transmission.

(16) Working through the right engine access, remove twelve bolts securing the transfer gear housing to the transmission. Refer to figure 2-13.

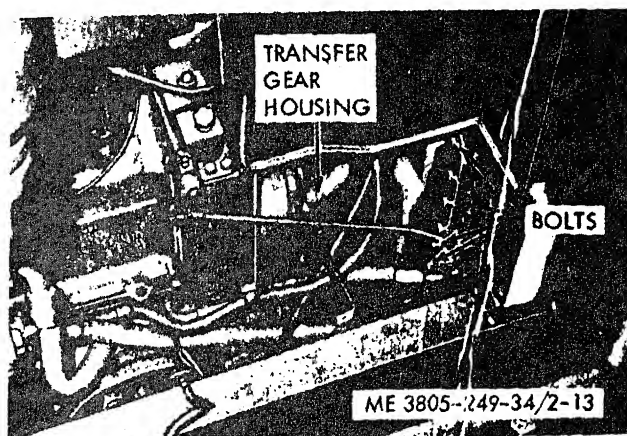


Figure 2-13. Transfer gear housing retaining bolts.

(17) On the transmission side, remove 25 nuts (fig. 2-14) securing the transfer gear housing to the transmission.



Figure 2-14. Transfer gear housing retaining nuts.

(18) Move the transmission forward until the transmission input shaft clears the transfer gear. Hoist the transmission away from the grader and lower to the ground or work table.

*Note.* The transmission weighs approximately 1900 pounds.

*b. Installation.* Install the transmission in the reverse order of removal. Observe the following:

(1) Tighten the transfer gear housing retaining bolts and nuts to a torque of 85 to 105 foot-pounds.

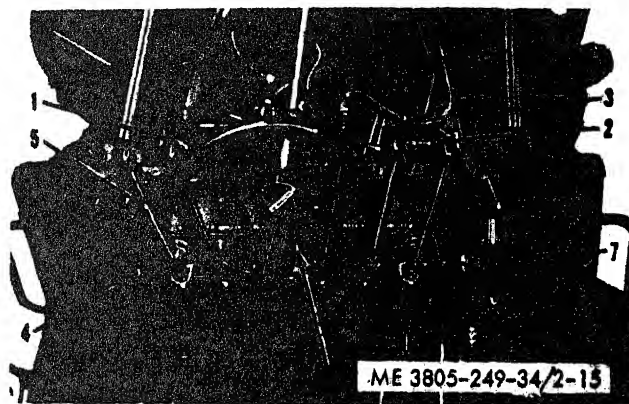
(2) Service the transmission as instructed in TM5-3805-249-12.

## 2-10. Power Control Clutches

### a. Removal. (fig. 2-15.)

(1) Remove the drain plug and drain lubricant from the clutch housing.

(2) Remove the blade lift brake assemblies (1 and 2). Refer to TM5-3805-249-12.



1. Blade lift brake
2. Blade lift brake
3. Drive shaft
4. Bolt, nut and lockwasher
5. Lever
6. Bolt and lockwasher
7. Cover

Figure 2-15. Removing clutch housing cover.

(3) Remove the bolts, lockwashers and keys securing the drive shafts (3) to the clutch output shafts.

(4) Remove the bolt, nut and lockwasher (4) securing each lever (5) and remove the lever.

(5) Remove sixteen bolts and lockwashers (6) and remove the cover (7).

(6) Remove the clutch from the housing by pulling outward.

*Note.* To remove the third clutch from the left, first remove one of the adjacent clutches. Pull the clutch outward until the shaft clears the inside of the housing, then move the clutch to the right or left.

*b. Installation.* Install the clutches in the reverse order of removal. Lubricate the sealing lips of the oil seal in the cover and housing. Apply a sealant to the threads of the bolts (6, fig. 2-15).

*Note.* When installing the clutch at the extreme left and extreme right, remove the plug in the bevel gear housing and work through the opening.

## 2-11. Power Control Column Housing (fig. 2-16.)

### a. Removal.

(1) Drain the lubricant from the power control clutch housing and the power control column housing.

(2) Remove the center floor plate. Refer to TM5-3805-249-12.

(3) Disconnect the power control drive shaft at the housing flange.



Figure 2-16. Power control column housing.

(4) Remove the hydraulic pump. Refer to TM5-3805-249-12.

(5) Attach a hoist to the column housing. Remove the bolts which secure the column housing to the clutch housing and to the frame crossmember. Lower the housing and remove it from beneath the vehicle.

*b. Installation.* Install the column housing in the reverse order of removal. Tighten bolts securely. Service the power control clutch housing and column housing with lubricant.

## 2-12. Blade Lift Assembly

### a. Removal.

(1) Lower the blade to the ground.

(2) Drain the lubricant from the clutch control housing and the blade lift control housing.

(3) Remove the blade lift control brake, lift arm, and lift link. Refer to TM5-3805-249-12.

(4) Remove the hydraulic pump mounting bolts and move the pump forward, leaving all lines attached.

(5) Remove the two top mounting bolts from the hydraulic oil reservoir. Insert two 8-inch 1/2 in. -13NC bolts in the top mounting holes. Remove the two bottom mounting bolts and move the tank forward. This will provide clearance for removing the blade lift control housing.

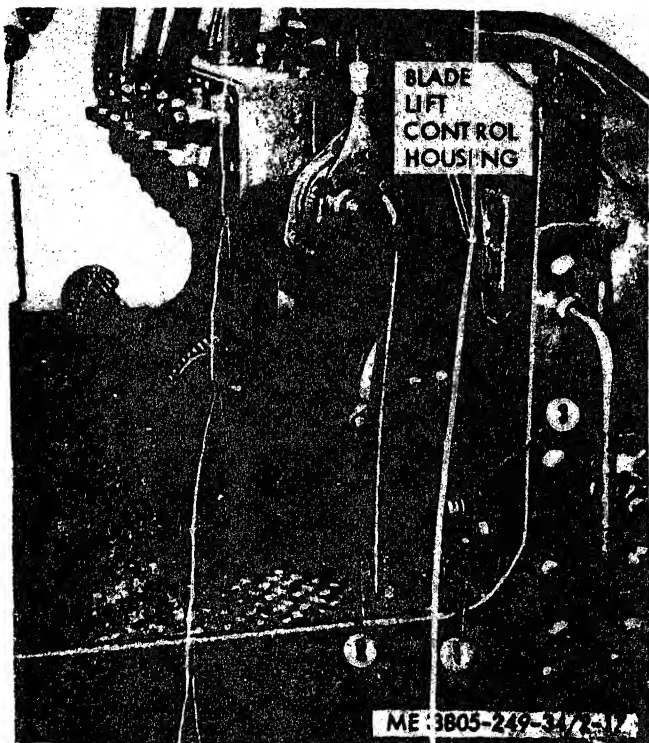
(6) Remove the hydraulic filter bolts and leave the filter suspended by its lines.

(7) Remove the bolt securing the governor control lever mounting bracket to the dash vertical support.

(8) Attach a sling and hoist to the blade lift assembly.

(9) Remove eight bolts and lockwashers securing the bevel pinion housing in position.

(10) Remove eleven nuts and lockwashers (1), three bolts (2) and two bolts, nuts and lockwashers (3) securing the blade lift assembly to the operator's compartment front plate. Refer to figure 2-17.



1. Nuts and lockwashers
2. Bolts
3. Bolts, nuts and lockwashers

Figure 2-17. Disconnecting blade lift assembly.

(11) Move the blade lift control assembly forward until the bevel pinion housing clears the shaft inside the housing. Remove the housing.

*Note.* If necessary, pry the bevel pinion housing off its locating dowels in the dash plate while moving the blade lift assembly forward.

(12) Move the blade lift assembly forward and upward, rotating as required to clear the dash plate.

(13) Pull the assembly toward the rear of the vehicle until the shaft clears its bracket on the frame. Lower the assembly to the ground.

*b. Installation.* Install the blade lift control in the reverse order of removal. Observe the following:

(1) Install the bevel pinion housing, leaving the bolts loose.

(2) Install the bolts (2, fig. 2-7), bolts, nuts and lockwashers (3) and nuts and lockwashers (1) but do not tighten.

(3) Then tighten the nuts (1, fig. 2-17) to a torque of 80 to 90 foot-pounds and the bolts (3) to a torque of 160 to 200 foot-pounds.

(4) Tighten the remaining hardware in the following order: bevel gear housing stud nuts, bevel gear housing bolts, bolts (2, fig. 2-13), and five housing retaining bolts.

(5) Install the lift arm, link and blade lift control brake and perform adjustments described in TM5-3805-249-12. Service the housings.

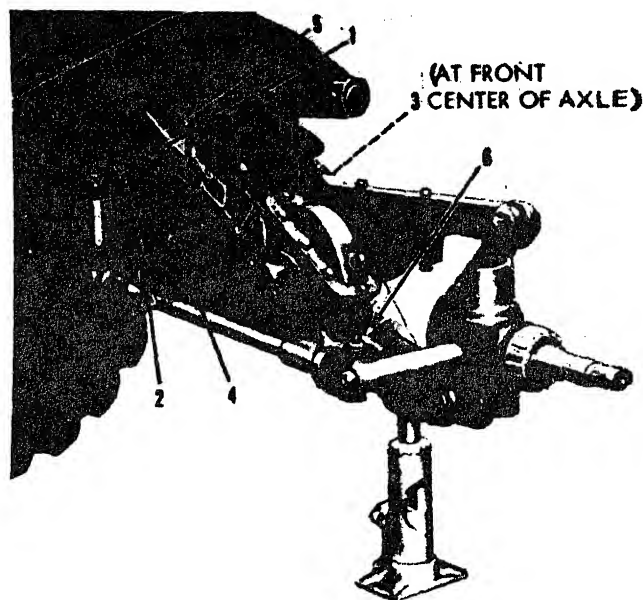
## 2-13. Front Axle

### a. Removal. (fig. 2-18.)

(1) Remove both front wheels and the leaning wheel tie bar. Refer to TM5-3805-249-12.

(2) Support the axle with a hoist.

(3) Remove the nut, cotter pin and cap (1), bolt, nut and lockwasher (2) and pivot pin (3) which secure the axle to the front frame.



1. Nut, cotter pin and cap
2. Bolt, nut and lockwasher
3. Pivot pin
4. Bolster
5. Drive shaft
6. Axle assembly

Figure 2-18. Front axle assembly.

(4) Lower the axle assembly enough to clear the bolster (4) and remove.

*Note.* The leaning wheel control drive shaft (5) will slide out of the drive member as the axle assembly (6) is lowered.

*b. Installation.* Install the front axle assembly in the reverse order of removal.

## 2-14. Circle Assembly

### *a. Removal.* (fig. 2-19.)

(1) Lower the blade to the ground.

(2) Remove the bolts, washers and nuts which secure the rear guide shoes to the circle. Remove the guide shoes and retain the shims.

(3) Place blocking under the circle assembly and support the circle with a hoist.

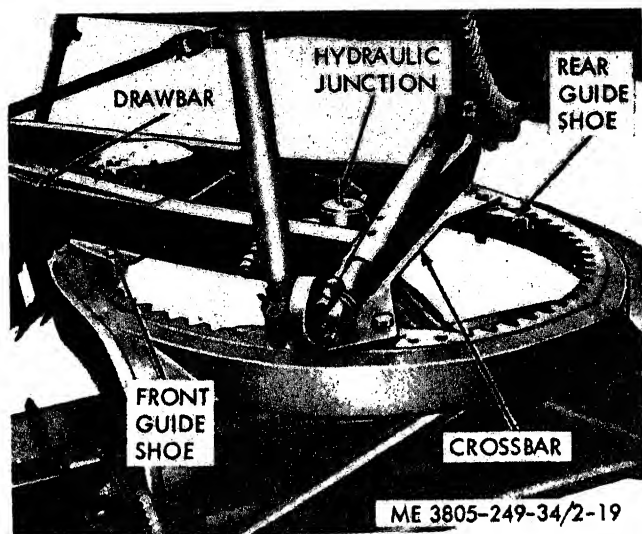


Figure 2-19. Circle assembly.

(4) Disconnect hydraulic oil lines at the hydraulic junction. Cap or plug openings.

(5) Remove the cotter pin, pin, nut and bolt securing the drawbar at the circle crossbar.

(6) Back the grader until the circle just clears the front guide shoes. Engage the blade lift controls and raise the drawbar away from the circle.

(7) Move the circle away from the grader. Remove the blade as instructed in TM5-3805-249-12.

### *b. Installation.*

(1) Install the circle in the reverse order of removal.

(2) Adjust the circle as described in TM5-3805-249-12.

(3) Start the engine and operate the blade through several complete cycles. Check for proper operation.

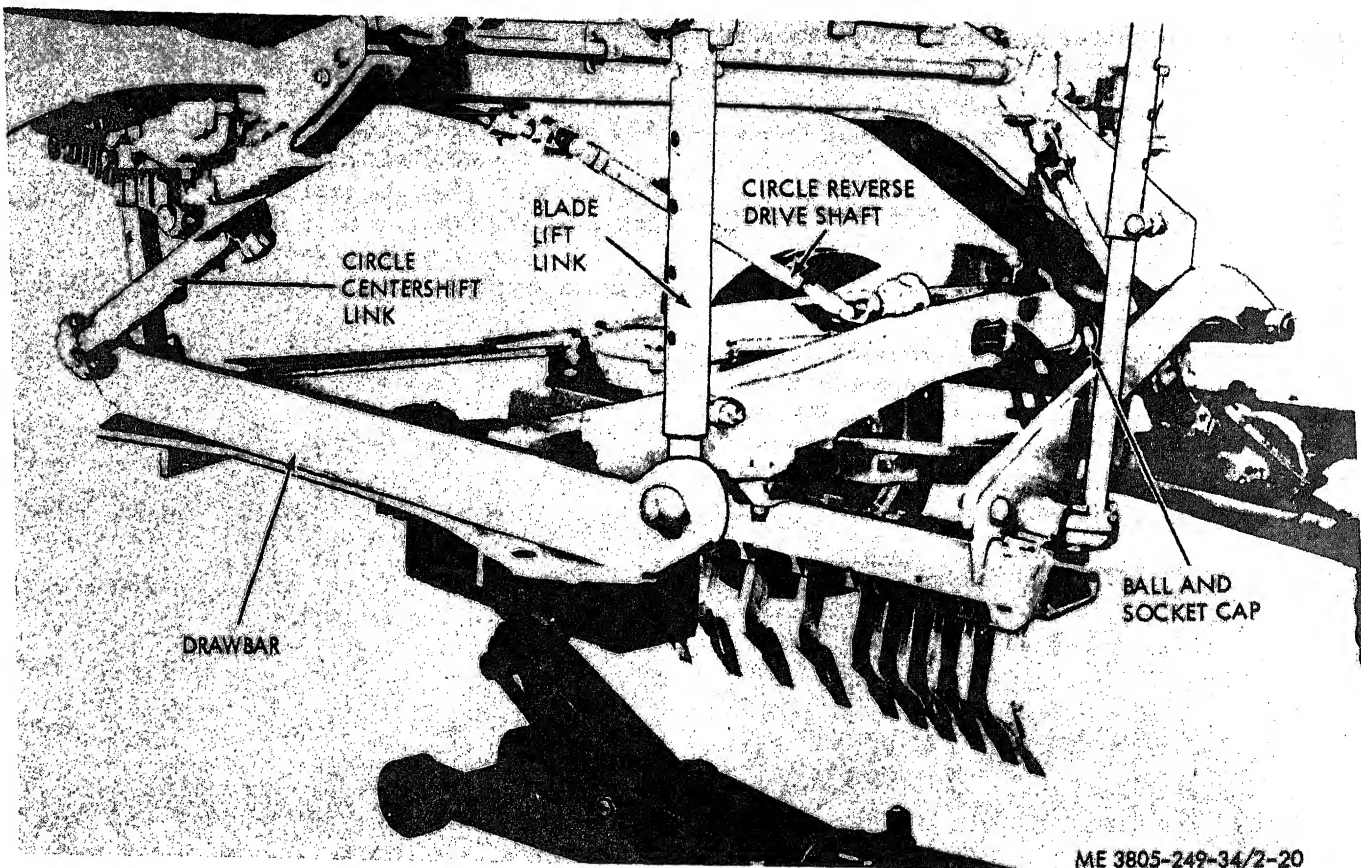
## 2-15. Drawbar Assembly

### *a. Removal.* (fig. 2-20.)

(1) Remove the circle (para 2-14).

(2) Support the drawbar with blocking and a floor jack.

(3) Disconnect the circle centershift link, blade lift links and circle reverse drive shaft from the drawbar. Tag shims and caps for proper installation.



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*Figure 2-20. Drawbar assembly.*

- (4) Remove the blade hydraulic lines.
- (5) Start the engine, engage the blade lift controls and raise the blade links. Shut down the engine.
- (6) Pull the rear of the drawbar to the right side of the grader.
- (7) Attach a hoist to the drawbar.

(8) Remove the nuts securing the ball and socket cap to the front axle.

(9) Hoist the drawbar away from the grader.  
*b. Installation.* Install the drawbar in the reverse order of removal. Adjust all ball and socket joints as instructed in TM5-3805-249-12.

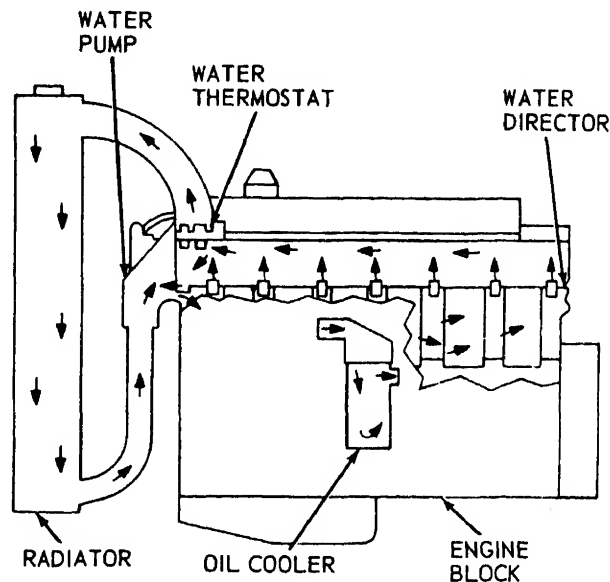
# CHAPTER 3

## REPAIR OF THE POWER PLANT

### Section I. COOLING SYSTEM

#### 3-1. General

Cooling system components are the radiator, water pump, water thermostat, oil cooler and lines, fittings and passages. Coolant pumped from the outlet side of the water pump flows directly into the front of the cylinder block and to the oil cooler. The coolant passes through the oil cooler, returns to the block, and flows around the cylinder liner walls to the precombustion chambers. The coolant then flows to the water thermostat. When the coolant becomes sufficiently warm, the thermostat opens to permit the coolant to return to the radiator. The coolant is cooled by air drawn across the radiator core and is then drawn back to the water pump. The cooling system is pressurized to permit safe operation at temperatures higher than the normal boiling point, prevent cavitation in the water pump and reduce the possibility of air pockets in the coolant passages. Refer to figure 3-1 for the cooling system schematic diagram.



#### 3-2. Radiator

a. *Removal.* Refer to TM5-3805-249-12.

b. *Disassembly.* (fig. 3-2.)

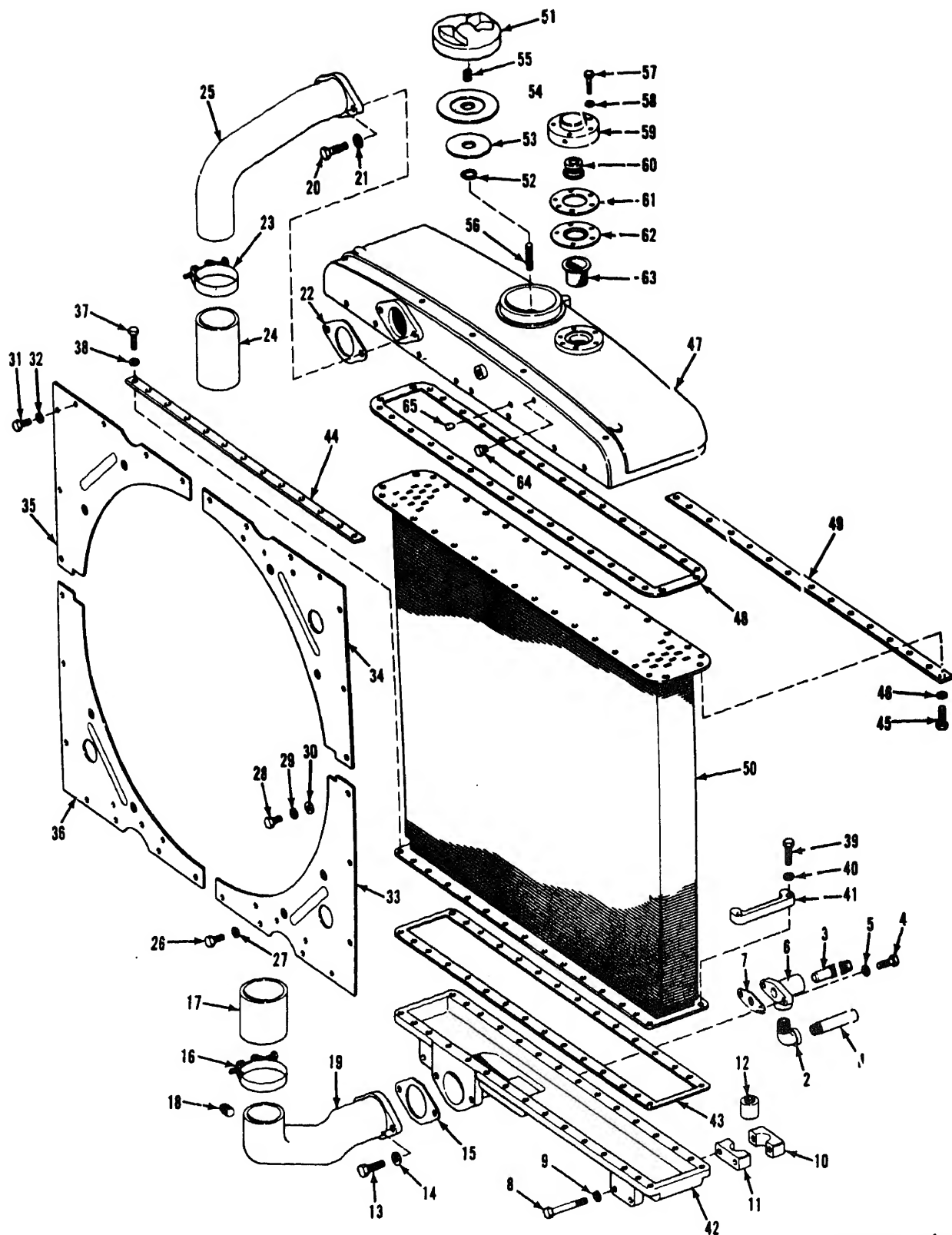
*Note.* Clean the exterior of the radiator thoroughly before disassembling.

(1) Remove the nipple (1) and adapter (2). Remove the plug (3), bolt (4), lockwasher (5), adapter (6) and gasket (7).

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Figure 3-1. Cooling system schematic diagram.





(2) Remove the bolt (8), lockwasher (9), clamp, (10 and 11) and block (12).

(3) Remove the bolt (13), lockwasher (14), gasket (15), clamp (16), hose (17), plug (18) and elbow (19).

(4) Remove the bolts (20), lockwashers (21), gasket (22), clamp (23), hose (24) and elbow (25).

(5) Remove the bolts (26, 28 and 31), lockwashers (27, 29 and 32) and washers (30). Remove the shields (33, 34, 35 and 36).

(6) Remove the bolts (37 and 39), lockwashers (38 and 40) and strip (41). Remove the tank bottom (42), gasket (43) and strip (44).

(7) Remove the bolts (45) and lockwashers (46). Remove the tank top (47), gasket (48) and strip (49) from the core (50).

(8) Remove the cap (51). Remove the retaining ring (52), retainer (53), gasket (54), and insert (55). Remove the stud (56).

(9) Remove the bolts (57) and washers (58) and lift off the cover (59). Remove the relief valve (60), gasket (61), plate (62) and strainer (63).

(10) Remove the plug (64) and cork (65) from the tank top.

c. *Cleaning.* Clean all components with solvent and flush with clean water. Dry with compressed air. Pay particular attention to the radiator core and ensure that all foreign materials are removed.

d. *Inspection and Repair.*

(1) Inspect all parts for leaks, cracks and other damage. Inspect parts for corrosion and deterioration. Repair or replace defective parts.

(2) Ensure that the interior of the radiator core is dry and immerse in water. Apply an air pressure not to exceed 12 psi and check for leaks. Repair leaks using a soft solder composed of 35 to 45% tin and 55 to 65% lead. Use a zinc chloride or resin flux. After soldering, flush the core with water. Check for restrictions.

(3) Straighten any bent fins in the radiator core. Be careful not to break soldered joints.

(4) Test the relief valve operation (subpara g) and replace if defective.

e. *Reassembly.* Assemble the radiator in the reverse order of disassembly.

f. *Installation.* Refer to TM5-3805-249-12.

g. *Relief Valve Test.*

(1) Tighten the radiator cap to seal the cooling system. Install a pressure gage capable of indicating 25 psi into the radiator tank top using appropriate fittings. Connect an air pressure regulating valve and an air source.

**Caution:** Do not apply a pressure greater than 16 psi.

(2) Slowly pressurize the radiator top tank. The highest pressure gage indication is the relief valve opening pressure. Indication should be 10 to 16 psi.

(3) If relief valve does not open within the specified limits, replace the valve.

3-3. *Water Pump*

a. *Removal.* Refer to TM5-3805-249-12.

b. *Disassembly.* (fig. 3-3.)

(1) Remove the bolts (1) and lockwashers (2) and remove the cover (3) from the water pump. Remove the seal (4).

(2) Remove the bolt (5) and washer (6).

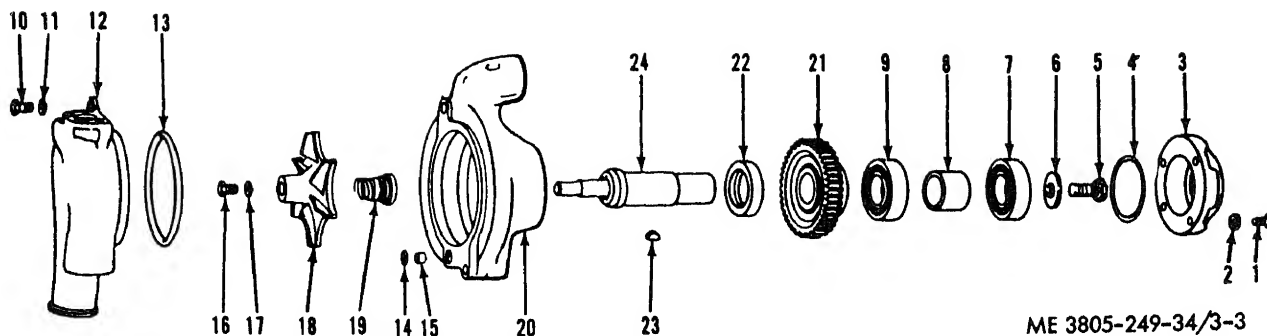
(3) Using a suitable puller, remove the bearing (7) from the impeller shaft. Remove the spacer (8) and bearing (9).

(4) Remove the bolts (10) and lockwashers (11). Remove the cover (12) from the body. Remove the seal (13), seal (14), and dowel (15).

KEY to fig 3-2:

1. Nipple	34. Shield
2. Adapter	35. Shield
3. Plug	36. Shield
4. Bolt	37. Bolt
5. Lockwasher	38. Lockwasher
6. Adapter	39. Bolt
7. Gasket	40. Lockwasher
8. Bolt	41. Strip
9. Lockwasher	42. Bottom, tank
10. Clamp	43. Gasket
11. Clamp	44. Strip
12. Block	45. Bolt
13. Bolt	46. Lockwasher
14. Lockwasher	47. Top, tank
15. Gasket	48. Gasket
16. Clamp	49. Strip
17. Hose	50. Core
18. Plug	51. Cap
19. Elbow	52. Retaining ring
20. Bolt	53. Retainer
21. Lockwasher	54. Gasket
22. Gasket	55. Insert
23. Clamp	56. Stud
24. Hose	57. Bolt
25. Elbow	58. Washer
26. Bolt	59. Cover
27. Lockwasher	60. Valve





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1. Bolt
2. Lockwasher
3. Cover
4. Seal
5. Bolt
6. Washer
7. Bearing
8. Spacer
9. Bearing
10. Bolt
11. Lockwasher
12. Cover

13. Seal
14. Seal
15. Dowel
16. Bolt
17. Washer
18. Impeller
19. Spring
20. Body
21. Gear
22. Seal
23. Key
24. Impeller shaft

Figure 3-3. Water pump, exploded view.

(5) Remove the bolt (16) and washer (17). Remove the impeller (18) and spring (19) from the impeller shaft.

(6) Remove the impeller shaft from the body (20).

(7) Remove the gear (21), seal (22), and key (23) from the impeller shaft (24).

c. *Cleaning.* Clean all components except bearings in solvent and dry with compressed air. Clean bearings as instructed in paragraph 2-6.

d. *Inspection and Repair.*

(1) Check the housings for cracks at the mounting flanges. Repair or replace as required.

(2) Inspect the impeller for dents, nicks, cracks, chips and bent or broken splines. Repair or replace as necessary.

(3) Inspect the bearing for scoring, wear, scratches, pitting and other damage. Replace as required.

(4) Replace all seals and gaskets.

e. *Reassembly.* Assemble the water pump in the reverse order of disassembly. Grease the seals before installing and use a seal installation tool to insert the seals. Tighten the impeller bolt (16, fig. 3-3) to a torque of 27 to 29 foot-pounds.

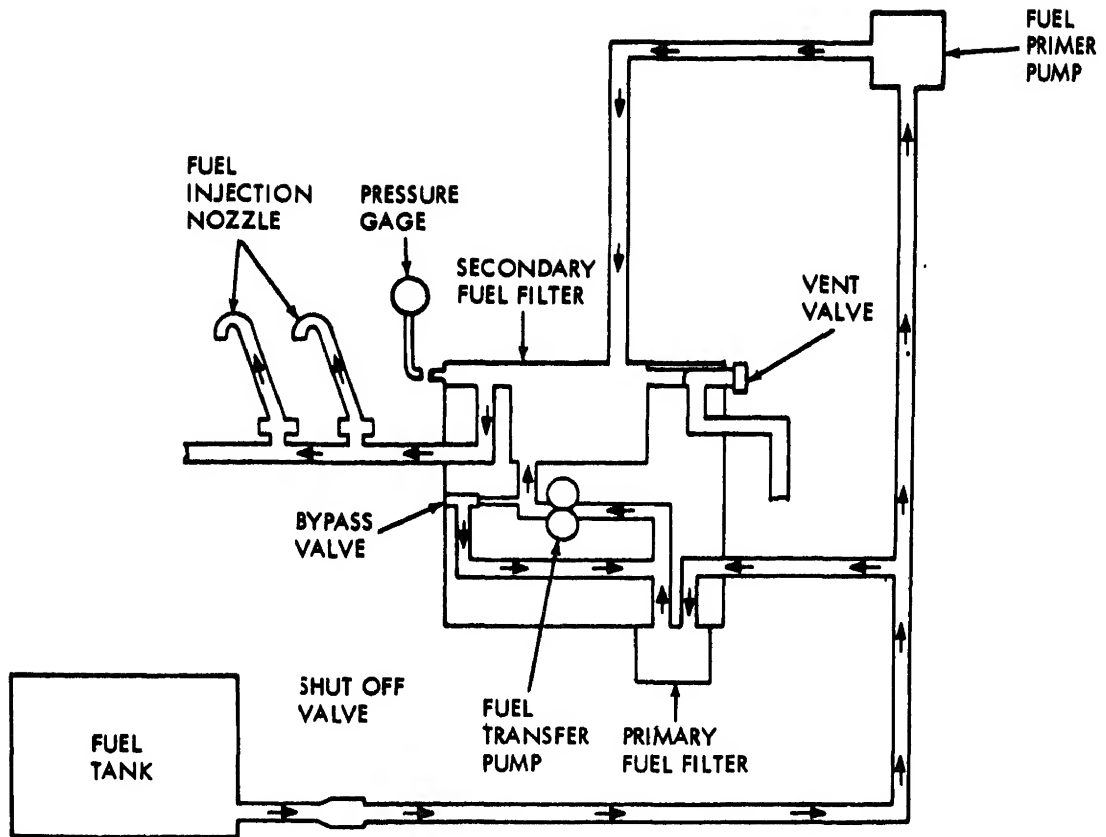
f. *Installation.* Refer to TM5-3805-249-12.

## Section II. FUEL SYSTEM

### 3-4. General.

The fuel system consists of a supply tank, fuel injection valves, fuel injection pump, pressure gage, fuel filters, transfer pump, vent valve and primer pump. The transfer pump draws fuel from the fuel tank and delivers the fuel through the primary and secondary fuel filters to the fuel injection pump.

The injection pump delivers the fuel under high pressure to the injection valves, where it is sprayed into the engine precombustion chambers. The accessory drive shaft drives the governor, fuel injection pump camshaft, service meter and fuel transfer pump. Refer to figure 3-4 for a diagram of the fuel system.



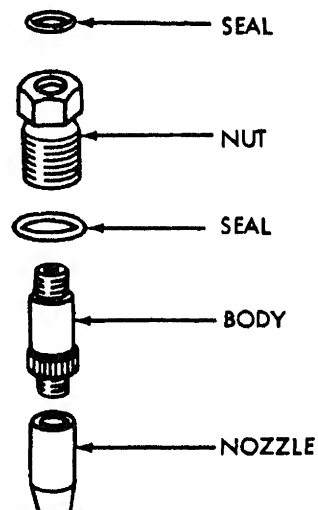
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Figure 3-4. Fuel system diagram.

### 3-5. Fuel Injection Valves

#### a. Removal and Disassembly. (fig. 3-5.)

(1) Disconnect the fuel line at the fuel injection valves. Cap or plug openings.



(2) Remove the nut securing the nozzle and body in the precombustion chamber.

(3) Lift out the nozzle and body and discard the two seals.

(4) Unscrew the nozzle from the body.

*b. Repair.* Inspect the nozzle for eroded orifice and plugged or broken screen. Replace the nozzle if necessary.

*c. Test.*

(1) Mount the injection nozzle in a fuel injection test stand which has a pressure regulating valve, a fuel supply shut-off valve, 0-1000 PSI gage, and a valve to block fuel flow to the gage.

(2) With fuel pressure to the nozzle regulated to 1875 PSI, block the flow of fuel to the pressure gage.

(3) Activate the tester and carefully observe the spray pattern from the injection nozzle. A completely atomized spray with a sharp cut-off of fuel and no air dribble indicates the nozzle is working properly. A solid stream of fuel with little or no atomization indicates the needle valve in the nozzle is not seating properly. Replace the nozzle if spray pattern is not satisfactory.

(4) With the tester running, slowly open the gage valve, allowing fuel to enter the gage.

(5) Check the nozzle needle valve unseating pressure. The normal pressure will fluctuate from 400 PSI to 800 PSI as registered on the gage. If the needle valve fails to reach a minimum pressure of 400 PSI, replace the nozzle.

(6) Stop the tester motor, and close the fuel supply line. Open the gage valve until pressure reading of 300 PSI is obtained. Observe the gage to determine if the nozzle is leaking. If pressure drops more than 100 PSI in 30 seconds, replace the nozzle.

*d. Reassembly and Installation.* (fig. 3-5).

(1) Install the nozzle on the body and tighten finger-tight. Insert the injection valve into the opening in the precombustion chamber.

(2) Install a new seal on the nut.

(3) Install the nut and tighten to a torque of 100 to 110 foot-pounds.

(4) Install new fuel injection line seal and install line on injection valve.

(5) Connect the fuel line.

(6) Bleed the fuel system as instructed in TM5-3805-249-12.

### 3-6. Fuel Injection Pump

*a. Removal.* (fig. 3-6.)

(1) Disconnect the linkage at the governor control lever.

(2) Disconnect the fuel injection lines at the housing. Cap or plug openings.

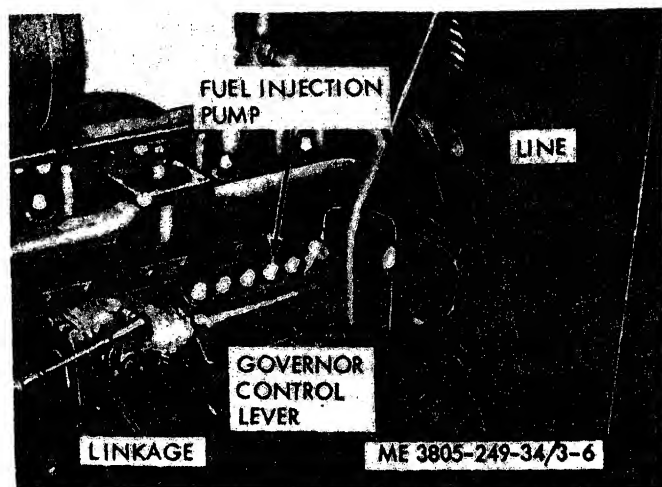


Figure 3-6. Fuel injection pump.

(3) Disconnect the oil line at the housing. Cap or plug openings.

(4) Remove the bolts which secure the fuel injection pump housing to the bracket. Remove the fuel injection pump housing and governor as an assembly.

(5) Remove the bolts securing the governor housing to the fuel injection pump housing, and separate the housings. Remove the gasket from the mounting face.

*b. Disassembly.* (fig. 3-7.)

*Note.* Clean the fuel injection pump housing thoroughly before disassembly.

(1) Remove the cap (1) and the felt washer (2).

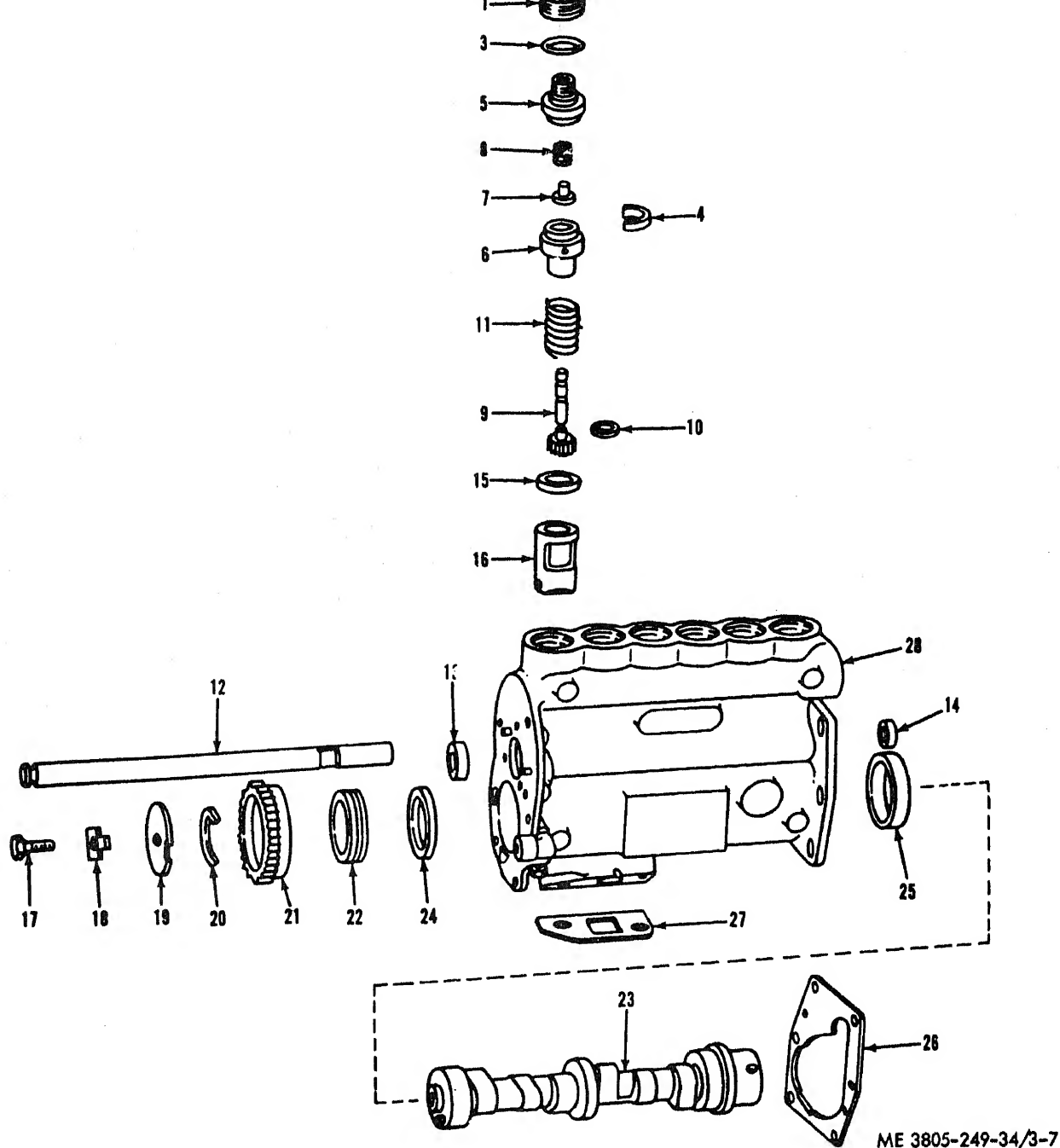


Figure 3-7. Fuel injection pump, exploded view.

(2) Remove the fuel injection pump retaining bushing (3) from the housing.

(3) Using an extractor, remove the fuel injection pump from the housing.

*Note.* Components of the fuel injection pumps cannot be interchanged. Tag parts for assembly with the same parts and installation in the same bore in the fuel pump housing.

(4) Remove the retaining ring (4) and separate the bonnet (5) from the barrel (6).

(5) Remove the check valve (7) and spring (8) from the bonnet.

(6) Remove the plunger (9), keeper (10) and spring (11) from the barrel (6).

(7) Remove the fuel rack (12) from the housing.

(8) Remove the bearing (13) from the housing.

(9) Scribe two marks on the housing above the groove on the bearing (14) and in line with the lubrication passage. Remove the bearing.

(10) Remove the spacer (15) and the valve lifter (16).

(11) Remove the bolt (17), lock (18), spring retainer (19) and spring (20).

(12) Remove the ring gear (21) and spacer (22).

(13) Remove the camshaft (23) from the

except  
with compressed air.  
in paragraph 2-6.

nts for cracks, chips,  
ing and wear. Repair or  
replace parts as required.

(2) Inspect the sliding surfaces of pump plungers for grooves and scratches. Ensure that edges are not rounded.

(3) Inspect the check valve collar for grooves and scratches. Replace if surfaces cannot be smoothed with emery cloth.

(4) Replace pump plungers and barrels as a unit.

(5) Replace the check valve as a unit.

(6) Inspect camshaft cams and camshaft bearings for wear. Replace as necessary.

(7) Inspect the control rod for worn notches.

(8) Replace pump plunger washers which show signs of wear.

(9) Measure pump plungers using a micrometer. Replace any plunger less than 2.5881

the bearing aligns with the oil passage in the housing. Install the bearing (24). Ensure that the bearings are flush with the face of the housing.

(2) Install the camshaft (23) in the housing.

(3) Install the spacer (22), ring gear (21), spring (20), spring retainer (19), lock (18) and bolt (17).

(4) Install the valve lifter (16) and spacer (15).

(5) Install the bearing (14) so that the hole in the bearing aligns with the marks made on the housing before removal. Install the bearing (13).

(6) Install the fuel rack (12).

(7) Install the spring (11), keeper (10) and plunger (9) in the barrel (6).

(8) Install the spring (8) and check valve (7) in the bonnet (5).

(9) Secure the bonnet (5) to the barrel (6) using retaining ring (4). Install the barrel and bonnet assembly in the fuel pump housing. Align the notches in the bonnet and barrel with the mark 180° from the gear center tooth. Align the notches with the guide pins in the housing bore. Align the pump gear center tooth with the fuel rack center notch.

(10) Press down on the barrel and bonnet assembly and install the retaining bushing (3) flush with the top of the housing. If the bushing cannot be properly installed, remove the barrel and bonnet, realine and reinstall. Tighten the bushing to a torque of 140 to 160 foot-pounds.

(11) Install the felt washer (2) and the cap (1).

*f. Installation.* Install the fuel injection pump in the reverse order of removal. Tighten bolts and fittings securely. Check and adjust timing (subpara g, h or i) and fuel rack setting (subpara j).

*g. Checking Fuel Injection Pump Timing (On Engine, Using a Timing Set).*

(1) Remove the rocker arm cover.

(2) Install a timing indicator set in the precombustion chamber of the pump to be tested. Follow instructions included with the indicator set. Disconnect the fuel line to the precombustion chamber. Cap or plug openings.

(3) Move the governor control to the full load position.

*Caution:* If shop air is used, connect a relief valve which will release pressure above 15 psi. Open the fuel shutoff valve.

(4) Maintain a 10 to 15 psi fuel pressure with the fuel priming pump or shop air.

(5) Rotate the crankshaft in its direction of

reaches maximum value. At this point the piston is at top dead center.

(7) At proper timing, the indicator reading should be 0.1091 (+0.0040) inch.

#### *h. Checking Fuel Injection Pump Timing (On Engine, Using a Gage).*

(1) Locate the top dead center compression position for the No. 1 piston.

(2) Remove the No. 1 fuel injection pump (subpara b, above). Insert a timing gage, into the fuel pump bore.

(3) Ensure that the higher step of the pump plunger is slightly above the top surface of the gage body and that the lower step of the plunger is just below the top surface of the gage body. If the gage cannot be correctly positioned, check accessory drive shaft timing (para 3-9).

(4) If the gage is correctly installed, the fuel pump is correctly timed.

#### *i. Setting Fuel Injection Pump Timing (Off Engine).*

*Note.* The fuel pump can be adjusted while removed from the engine only if a new engine or new timing gears, accessory drive shaft and fuel pump camshaft have been installed.

(1) Install a pointer on the fuel injection pump housing.

(2) Place the timing plate on the drive end of the camshaft and secure.

(3) Refer to table 3-1 and select the timing plate degree setting for the lifter to be set. Set the lifter to be set. Set the timing plate by rotating it counterclockwise until the proper degree setting aligns with the pointer. Lock in position with the setscrew.

(4) The fuel injection pump timing dimension is 4.2675 ( $\pm 0.0005$ ) inches. Remove the individual fuel pumps and add spacers below the lifters as necessary to adjust timing.

#### *j. Setting Fuel Rack.*

(1) Remove the rack cover from the front of the accessory drive housing rear flange (para 3-9). Remove the cover from the rear of the governor housing (para 3-7).

(2) Install a rack setting gage over the front end of the fuel rack.

(3) Loosely install a plug and push rod in the governor plug (48, fig. 3-8) hole. Force the speed limiter away from the plug hole.

(4) Move the governor control lever forward until the stop collar on the fuel rack just touches the stop bar on the torque spring. If necessary, insert a 0.003 inch feeler gage between the stop and spring to held determine the point of contact.

*Table 3-1. Lifter setting*

Lifter number	Timing plate degrees
1	179 ° 30'
2	59 ° 30'
3	299 ° 30'
4	119 ° 30'
5	239 ° 30'
6	359 ° 30'

(5) Position the rack setting gage from the zero position until it contacts the rack. Total rack travel should be 0.650 inch.

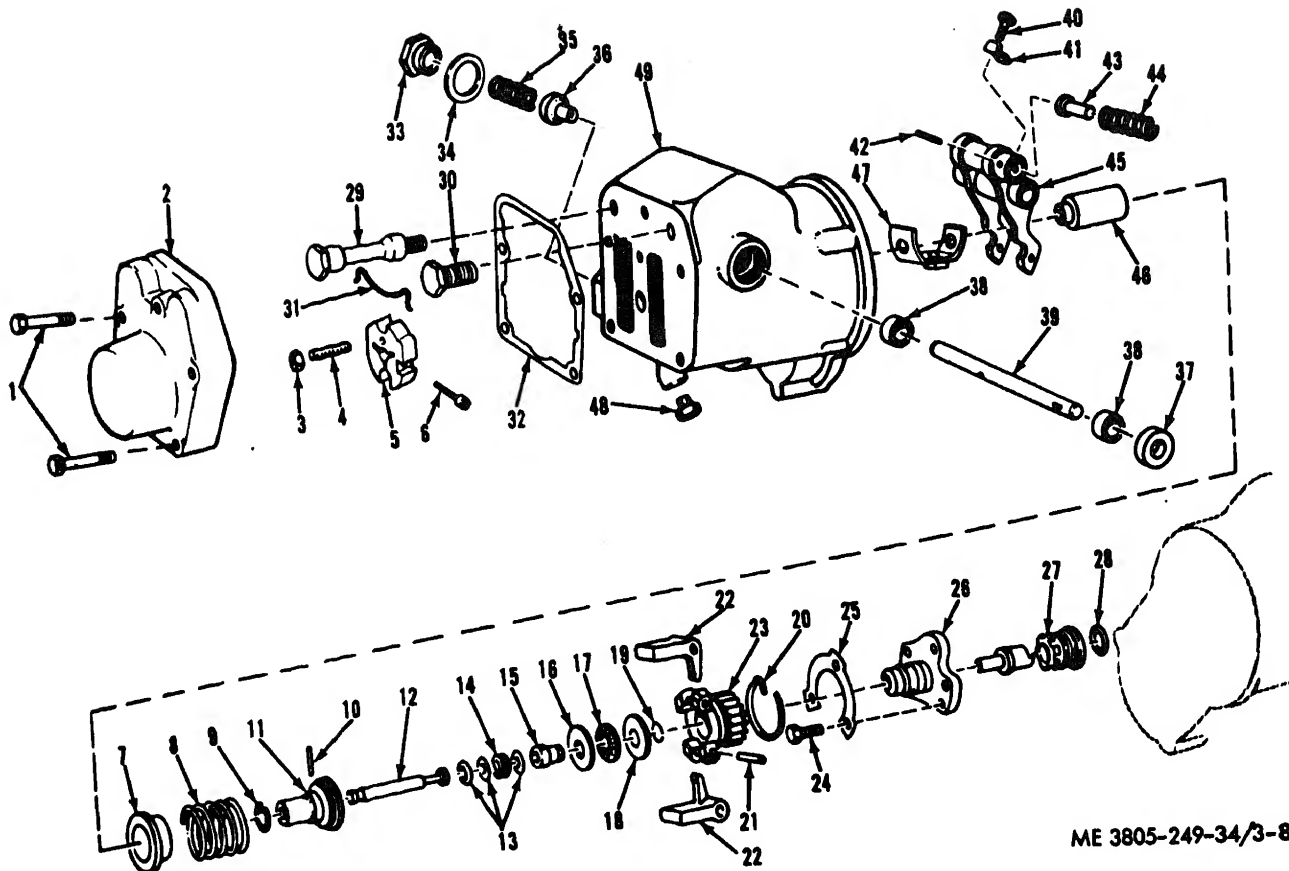
(6) To adjust the rack, loosen the locknut (fig. 3-8) and turn the adjusting screw (4) to obtain the desired setting. Tighten the locknut.

#### **3-7. Engine Speed Governor**

*a. Removal.* Remove the engine speed governor with the fuel injection pump. Refer to paragraph 3-6.

##### *b. Disassembly.* (fig. 3-8.)

(1) Remove the bolts (1) and remove the governor cover (2).



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1. Bolt
2. Cover
3. Locknut
4. Screw
5. Collar
6. Screw
7. Plunger
8. Spring
9. Washers
10. Pin
11. Seat
12. Bolt
13. Washer
14. Spring
15. Seat
16. Ring
17. Race
18. Bearing
19. Ring
20. Snap ring
21. Dowel
22. Weight
23. Gear
24. Bolt
25. Lock

26. Servo cylinder
27. Piston
28. Seal
29. Screw
30. Screw
31. Spring
32. Gasket
33. Plug
34. Washer
35. Spring
36. Plunger
37. Seal
38. Bearing
39. Shaft
40. Bolt
41. Lock
42. Pin
43. Plunger
44. Spring
45. Lever
46. Guide
47. Band
48. Plug
49. Housing

Figure 3-8. Engine speed governor, exploded view.

(5) Remove the washers (13), spring (14) and seat (15).

(6) Remove the ring (16), race (17), bearing (18) and ring (19).

(7) Remove the snap ring (20) and remove the weight assembly. Remove the dowels (21) and separate the weights (22) from the gear (23).

(8) Remove the bolts (24), lock (25) and the servo cylinder (26). Remove the piston (27) and the seal (28).

(9) Remove the low idle adjusting screw (29) and the high idle adjusting screw (30). Remove the spring (31) and the gasket (32).

(10) Remove the plug (33), washer (34), spring (35) and low idle stop plunger (36).

(11) Remove the seal (37), bearings (38) and governor control shaft (39).

(12) Remove the bolt (40), lock (41) and lever assembly. Remove the pin (42), plunger (43) and spring (44) from the lever (45).

(13) Remove the guide (46) and the band (47).

(14) Remove the plug (48) from the housing (49).

*c. Cleaning.* Clean all components with solvent and dry with compressed air.

*d. Inspection and Repair.*

(1) Inspect the housing and cover for breaks, cracks and rough mating surfaces. Repair by welding.

(2) Inspect control levers for cracks, breaks and worn bores. Inspect pins for wear and damage. Replace worn parts.

(3) Inspect springs for cracks and other damage. Replace weak or damaged springs.

(4) Inspect rollers and bushings for wear. Replace bushings if worn or loose. Replace rollers if worn or out-of-round.

*e. Reassembly.* (fig. 3-8.)

(1) If the guide (46) was removed, press a new guide into position in the housing (49). From the guide against the chamfer in the governor housing. Install the band (47).

(2) Install the spring (44), plunger (42) and pin (42) to the lever (45). Install the lever assembly in the housing and secure with the lock (41) and bolt (40).

(3) Press on new bearings (38) and install the governor control shaft (39) and seal (37).

(4) Install the low idle stop plunger (36), spring (35), washer (34) and plug (33). Install the plug (48).

(5) Install a new gasket (32). Install the low idle adjusting screw (29), high idle adjusting screw (30) and spring (31).

(6) On the face of the fuel injection pump housing, install the seal (28), piston (27), servo cylinder (26), lock (25) and bolts (24).

(7) Secure the weights (22) to the gear (23) using dowels (21). Install the weight assembly to the servo cylinder (26) and secure with the snap ring (20).

(8) Install the ring (19), bearing (18), race (17), ring (16) and seat (15). Install the washers (13), spring (14) and full load stop bolt (12). Install the seat (11) and secure with pin (10). Install the spring washer (9), spring (8) and plunger (7).

(9) Install the adjusting screws (4 and 6) in the collar (5). Install the locknut (3). Install the cover (2) with the bolts (1).

*f. Installation.* Install the governor in the reverse order of removal. Check and adjust the idle speed settings (subpara g) as necessary.

*g. Adjustment.*

(1) Using a tachometer known to be accurate, check engine speed with the governor set in the low idle rpm position. Tachometer indication should be 650 rpm.

(2) If necessary, remove the governor cover (item 2, fig. 3-8). Turn the low idle adjusting screw (29) counterclockwise or clockwise as required to correct low idle speed.

(3) Check engine speed with the governor in the high idle rpm position. Tachometer indication should be 2000 rpm.

(4) Turn the high idle adjusting screw (30) as necessary to correct the high idle speed.

(5) Place the governor control lever in an intermediate setting rpm then recheck low idle and high idle settings. Repeat adjustments as necessary.

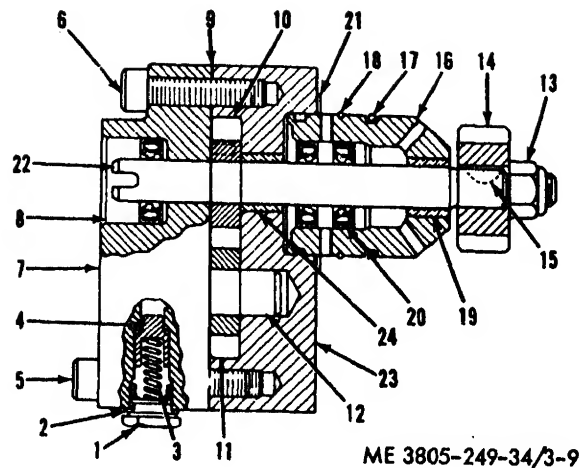
**3-8. Fuel Transfer Pump**

*a. Removal.* Refer to TM5-3805-249-12.

*b. Disassembly.* (fig. 3-9.)

(1) Remove the bolt (1), gasket (2), spring (3) and plunger (4).





1. Bolt
2. Gasket
3. Spring
4. Plunger
5. Screw
6. Screw
7. Cover
8. Seal
9. Gasket
10. Gear
11. Gear
12. Shaft

13. Nut
14. Gear
15. Key
16. Bearing cage
17. Seal
18. Ring
19. Bearing
20. Seal
21. Gasket
22. Shaft
23. Body
24. Bearing

Figure 3-9. Fuel transfer pump, cross section.

(2) Remove the screws (5 and 6) and remove the cover (7). Remove the seal (8) from the cover. Remove the cover mounting gasket (9).

(3) Remove the gear (10) from the shaft (22). Remove the gear (11) and shaft (12).

(4) Remove the nut (13). Pull the gear (14) from the shaft and remove the key (15).

(5) Remove the bearing cage (16). Remove the seal (17), ring (18) and the bearing (19). Remove the gasket (21).

(6) Remove the shaft (22) from the body (23). Press out the bearing (24).

c. *Cleaning.* Clean all components except bearings with solvent and dry with compressed air. Clean bearings as instructed in paragraph 2-6.

d. *Inspection and Repair.*

(1) Inspect the cover and housing for cracks, chips, nicks, and other damage. Check for cracks and rough spots at the mating surface. Repair or replace as required.

(2) Inspect the spring for cracks and weak condition. Replace if necessary.

(5) Inspect the bearings for wear, nicks, scratches, pitting and other damage.

e. *Reassembly.* Assemble the pump in the reverse order of disassembly. Observe the following:

(1) Install the bearings so that the tapered edges are toward seals.

(2) Soak seals (8 and 17, fig. 3-9) in a solution of 1 part SAE 30 oil to one part diesel fuel to soften the seals. Tamp the seals firmly into the pump body bore and around the shaft using a tamping tool.

(3) Install the gear (14) so that the grooved side is out.

(4) Tighten the nut (13) to a torque of 10 foot-pounds.

(5) Apply a thin film of sealant to the mating surfaces of the pump body (23) and cover (7). Do not allow excess sealant to enter the pump.

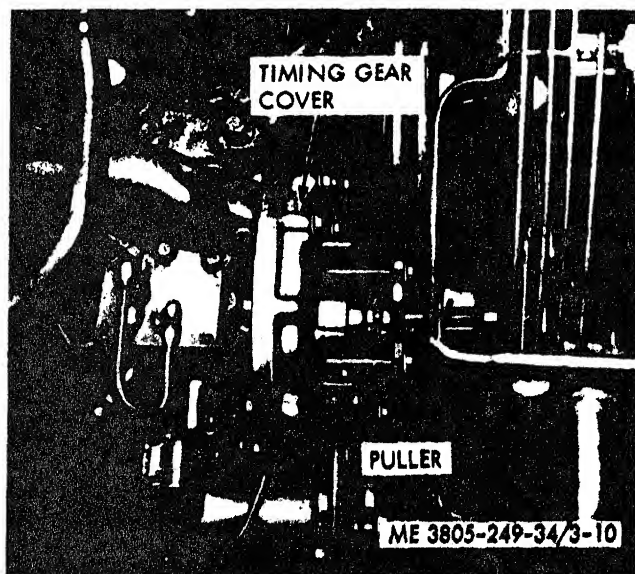
f. *Installation.* Refer to TM5-3805-249-12.

### 3-9. Accessory Drive

a. *Removal.* (fig. 3-10.)

(1) Remove the fuel transfer pump and fuel filter housing. Refer to TM5-3805-249-12.

*Note.* The accessory drive shaft can be removed without removing the timing gear cover.



*Figure 3-10. Accessory drive shaft removal.*

**Caution:** Do not allow the bolts or locks to fall into the timing gear housing.

(4) Position the accessory drive gear to allow access to the bolts which secure the accessory drive housing to the timing gear plate. Remove the bolts and locks.

(5) Remove the accessory drive gear retaining nut.

(6) Install puller and push the accessory drive shaft until the gear comes off the shaft and the accessory drive is removed from the timing gear housing.

(7) Pull the bearing from the shaft.

(8) Discard the housing mounting gasket.

#### *b. Cleaning, Inspection and Repair.*

(1) Clean the shaft, cover and gear in solvent and dry with clean, lint-free cloths or with compressed air. Clean the bearing as instructed in paragraph 2-6.

(2) Inspect the gear for broken, damaged or missing teeth. Replace as necessary.

(3) Inspect the shaft for damage, distortion and wear. Inspect the bearing contact surface for uneven or excessive wear. Repair as required.

#### *c. Installation.*

(1) Press the bearing onto the shaft. Install the bearing retaining plate.

**Caution:** Do not allow the bearing retaining plate to fall into the timing gear housing when installing the drive shaft.

(2) Install the drive shaft into the timing gear housing.

(3) Time the accessory drive shaft (subpara d).

(4) Install the gear and secure with the retaining nut. Tighten the nut to a torque of 90 to 110 foot-pounds.

(5) Install the accessory drive housing to the timing gear plate and secure with bolts and locks.

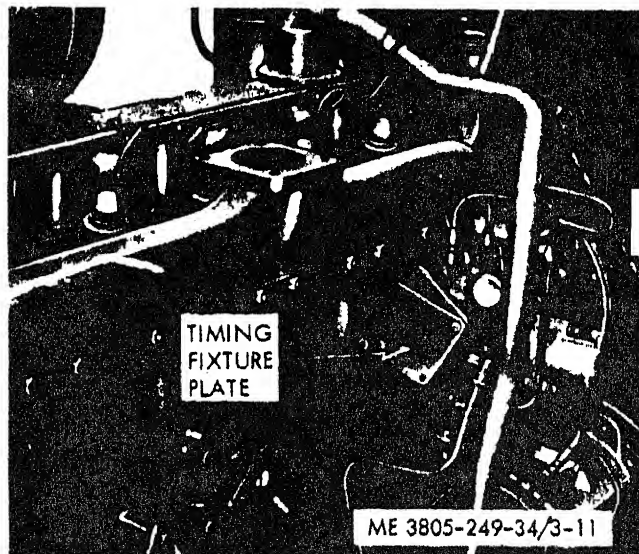
(6) Install the fuel injection pump housing and governor (para 3-6). Install the fuel transfer pump and fuel filter housing as instructed in TM5-3805-249-12.

#### *d. Timing.*

(1) Remove the fuel injection pump housing (para 3-6) and position the engine crankshaft so that the No. 1 piston is at top dead center (TDC) of compression stroke.

(2) Install a timing fixture plate on the rear face of the accessory drive housing as shown in figure 3-11.

*Note.* If the timing fixture plate can be installed, timing is correct. If it cannot be installed, continue with this timing procedure.



*Figure 3-11. Timing fixture plate installed.*

(3) Remove the small cover from the front of the timing gear housing. Remove the accessory drive gear retaining nut and washer.

(4) Separate the gear from the accessory drive shaft.

(5) Rotate the accessory drive shaft as

necessary to permit installation of the timing fixture plate.

(6) Insert the shaft through the gear. Tighten the gear retaining nut to a torque of 90 to 110 foot-pounds and remove the timing plate. Install the fuel injection pump housing (para 3-6).

### Section III. ELECTRICAL SYSTEM

#### 3-10. General

The grader electrical system supplies the power to start the engine and operate the lights and instruments. The system consists of batteries, a brushless alternator with internal regulator, starting motor with solenoid, and wiring, switches and other electrical components. Refer to figure 1-3 (in back of this manual) for the grader wiring diagram.

#### 3-11. Starting Motor

a. *Removal and Installation.* Refer to TM5-3805-249-12.

b. *Repair.* Repair of the starting motor is restricted to replacement of brushes. If additional repairs are necessary, replace the starting motor.

(1) Remove the bolts and lockwashers which secure the end plate to the starter housing. Refer to figure 3-12.

(2) Disconnect the field winding leads from the brush holder.

(3) Remove the screws which secure the brush leads to the brush holders. Pull back the springs and replace the brushes.

(4) Reconnect field windings and connect the new brush leads. Install the end plate.

#### 3-12. Wiring and Wiring Harness Repair

- a. Replace or repair broken, frayed or cracked insulation.
- b. Resolder or replace broken terminals.
- c. Repair shorted connections.
- d. Replace broken wires and connections.
- e. Clean corroded terminals with abrasive cloth or replace as necessary.
- f. Replace defective wiring harness.
- g. Replace broken or defective battery cables.

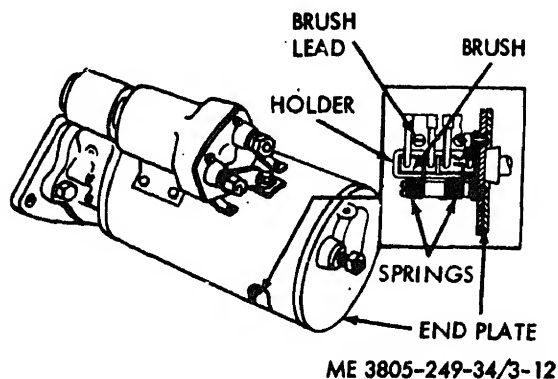


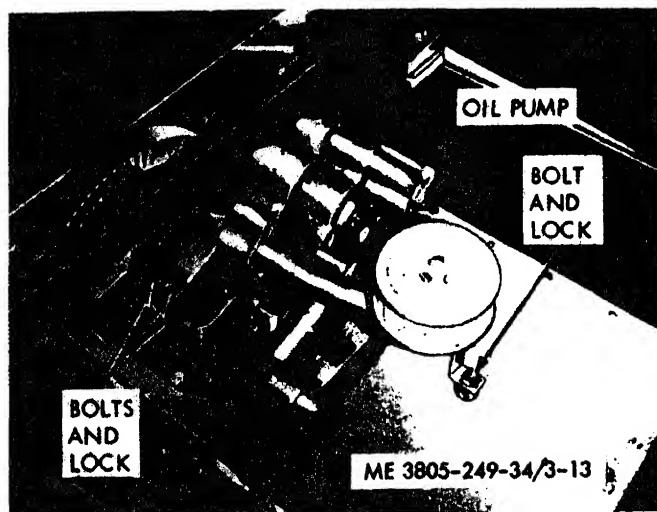
Figure 3-12. Starter brush replacement.

### Section IV. ENGINE LUBRICATING SYSTEM

#### 3-13. General

#### 3-14. Oil Pump

(3) Remove the bolts and locks which secure the oil pump to the cylinder block and remove the oil pump. Refer to figure 3-13.



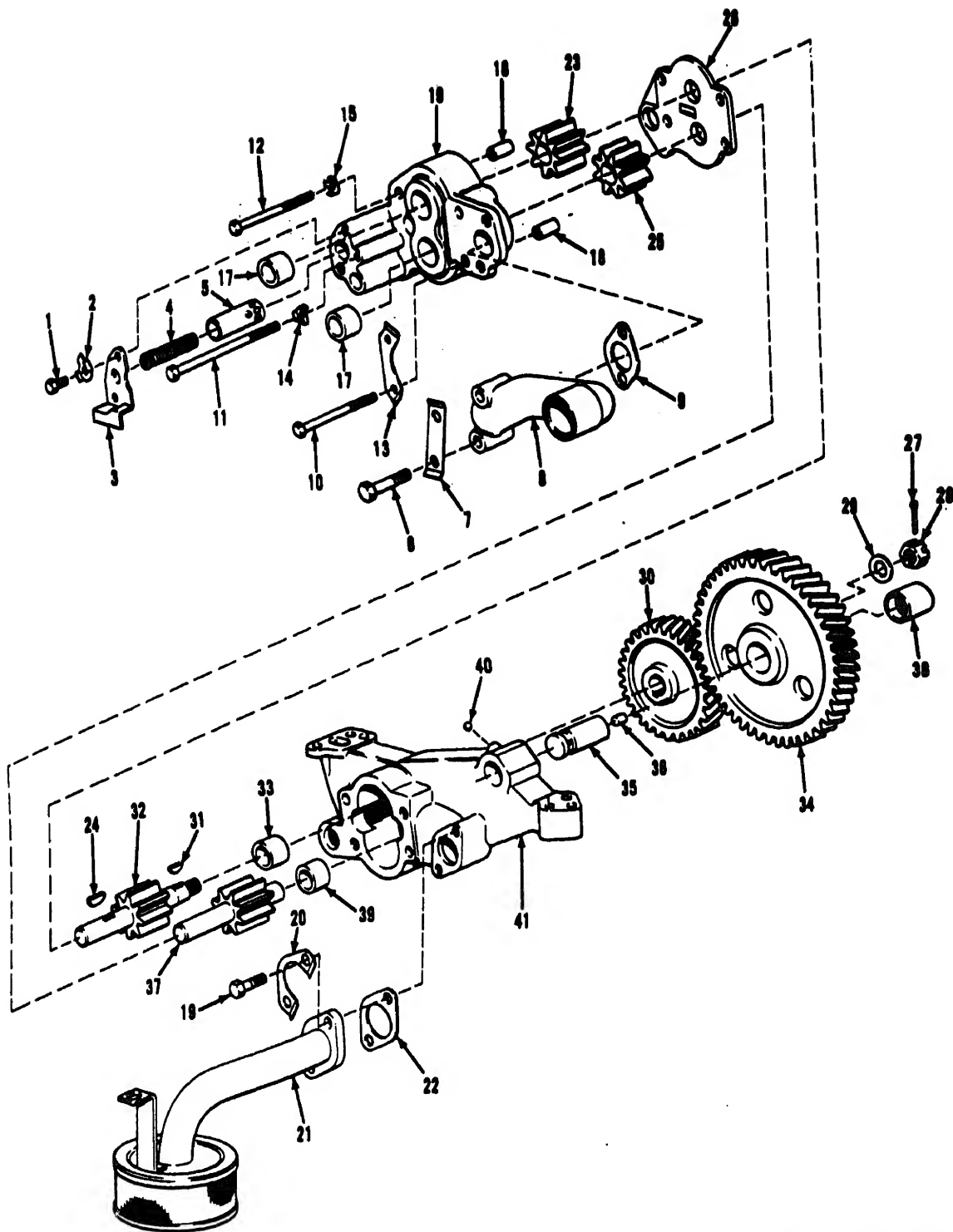
*Figure 3-13. Oil pump.*

**b. Disassembly. (fig. 3-14.)**

(1) Remove the bolts (1), lock (2) and cover (3). Remove the spring (4) and plunger (5).

(2) Remove the bolts (6), lock (7), elbow (8) and gasket (9).

(3) Remove the bolts (10, 11 and 12) and locks (13, 14 and 15). Remove the scavenge pump body (16) from the oil pump body and press out the bearings (17) and pins (18).



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Figure 3-14. Oil pump. exploded view.

(5) Remove the scavenge pump drive gear (23), key (24), driven gear (25) and spacer (26).  
 (6) Remove the cotter pin (27), nut (28) and washer (29). Using a puller, remove the drive gear (30) and key (31). Remove the shaft (32) from the oil pump body (41). Drive out the bearing (33).  
 (7) Remove the idler gear (34), shaft (35), dowel (36) and shaft (37). Remove the bearings (38 and 39).

(8) Remove the ball (40) from the oil pump body (41).

**c. Cleaning.** Clean all parts except bearings with solvent and dry with clean, lint-free cloths or compressed air. Clean bearings as instructed in paragraph 2-6.

**d. Inspection and Repair.**

(1) Inspect all parts for nicks, burrs, cracks or other damage. Remove small nicks or burrs with a hone or crocus cloth.

(2) Inspect all parts for wear. If any part is excessively worn, replace the pump.

**e. Reassembly.** Assemble the pump in the reverse order of disassembly. Observe the following:

(1) Ensure that all parts, tools and the work area are clean.

(2) Lubricate parts in engine oil before assembling.

(3) Tighten the nut (28, fig. 3-14) to a torque of 60 foot-pounds.

**f. Installation.**

(1) Install the oil pump in the reverse order of removal. Install new gaskets at oil line connections.

(2) Check the backlash between the oil pump idler gear and the crankshaft gear. If backlash exceeds 0.008 inch, replace the idler gear.

**KEY to fig 3-14:**

1. Bolt	21. Suction bell
2. Lock	22. Gasket
3. Cover	23. Gear
4. Spring	24. Key
5. Plunger	25. Gear
6. Bolt	26. Spacer
7. Lock	27. Cotter pin
8. Elbow	28. Nut
9. Gasket	29. Washer
10. Bolt	30. Gear
11. Bolt	31. Key
12. Bolt	32. Shaft
13. Lock	33. Bearing
14. Lock	34. Gear
15. Lock	35. Shaft
16. Body	36. Dowel
17. Bearing	37. Shaft
18. Pin	38. Bearing
19. Bolt	39. Bearing
	40. Ball

### 3-15. Oil Pan and Oil Pan Plate

**a. Removal.** (fig. 3-15.)

**Note.** The oil pan can be removed while the engine is installed in the grader. If the oil pan plate must be removed, remove the engine (para 2-7).

(1) Drain the lubricating oil from the oil pan.

(2) Remove the oil level dipstick.

(3) Remove the bolts and lockwashers that secure the oil pan to the timing gear cover and the oil pan plate.

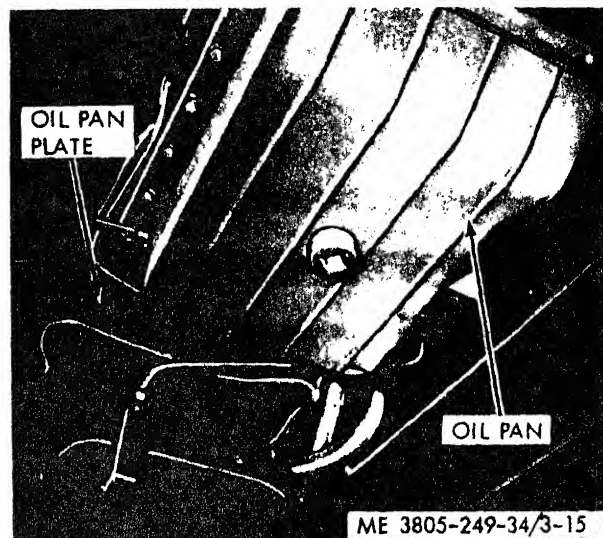


Figure 3-15. Oil pan and oil pan plate.

(4) Separate the oil pan gasket from the oil pan so that the gasket remains with the oil pan plate. Remove the oil pan.

(5) If the oil pan plate is to be removed, remove the bolts and lockwashers which secure it to the cylinder block and flywheel housing. Remove the oil pan plate and oil pan gasket.

**b. Cleaning.** Clean the oil pan and oil pan plate with solvent. Ensure that all sediment is removed from the sump in the oil pan.

**c. Inspection and Repair.** Inspect the oil pan and oil pan plate for chips, cracks, weld damage, warpage and other damage. Smooth contact surfaces with a hone or file. Repair cracks by welding. Replace parts if warpage is excessive.

**d. Installation.** Install the oil pan and oil pan plate by reversing the removal procedure. Use a new oil pan gasket. Service the engine as instructed in TM5-3805-249-12.

### 3-16. General

The six cylinder diesel engine has a displacement of 638 cubic inches and an output of 121 horsepower at 2000 rpm.

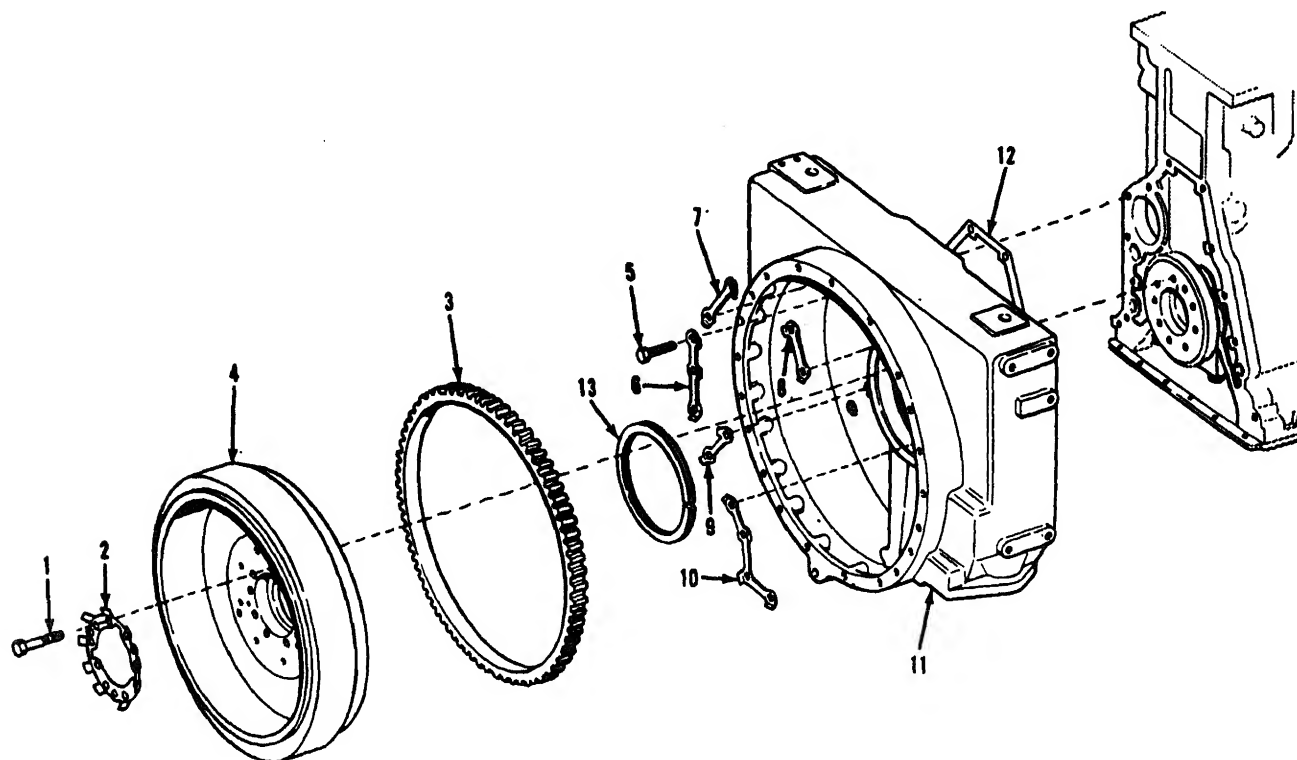
The engine is mounted over the rear axle. The flywheel housing is bolted to the flywheel clutch housing on the transmission. The flywheel gear engages with the flywheel clutch and drives the transmission. Engine driveshafts also drive the fan, alternator and water pump and the fuel pumps and service meter.

### a. Removal and Disassembly. (fig. 3-16.)

(1) Remove the engine from the grader (para 2-7) and block in position.

(2) Remove the starting motor as instructed in TM5-3805-249-12. Remove the flywheel clutch components (para 4-2).

(3) Remove two diagonally opposed flywheel retaining bolts (1) and install two  $\frac{5}{8}$  in. -18NF guide pins.



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- 1. Bolt
- 2. Lock
- 3. Ring gear
- 4. Flywheel
- 5. Bolt
- 6. Lock
- 7. Lock

- 8. Lock
- 9. Lock
- 10. Lock
- 11. Flywheel housing
- 12. Gasket
- 13. Seal

Figure 3-16. Flywheel and flywheel housing, exploded view.

(4) Remove the remaining retaining bolts (1) and the lock (2). Carefully slide the flywheel assembly onto the guide pins and attach a suitable hoist. Remove the flywheel assembly.

(5) Inspect the ring gear (3) and press, cut or burn it from the flywheel (4) if replacement is necessary.

(6) Remove the bolts which secure the oil pan plate to the flywheel housing.

(7) Loosen the bolts which secure the oil pan and oil pan plate to the cylinder block.

(8) If the engine is being supported by the oil pan and oil pan plate, raise the cylinder block and insert two  $\frac{1}{4}$ -inch shims between the cylinder block

and oil pan at the rear of the engine. Be careful not to damage the oil pan plate gasket.

(9) Attach a suitable hoist to support the flywheel housing. Remove the flywheel housing retaining bolts (5) and locks (6, 7, 8, 9, and 10). Remove the flywheel housing (11). Discard the mounting gasket (12) and seal (13).

**b. Cleaning.** Clean all components in solvent. Dry with clean, lint-free cloths.

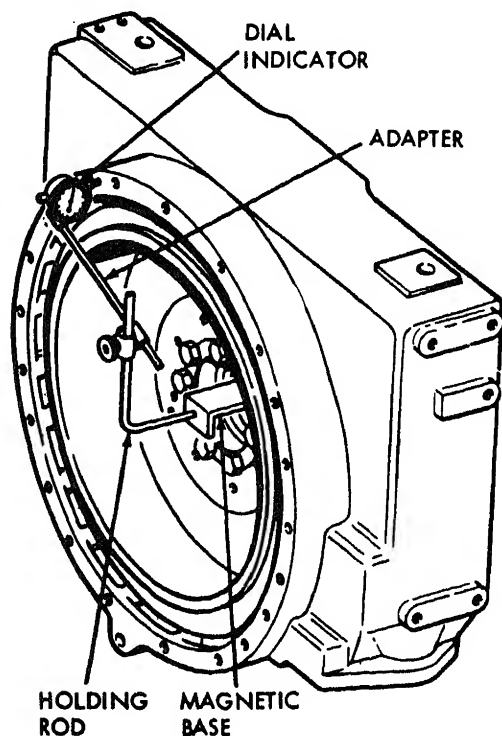
**c. Inspection and Repair.**

(1) Inspect the housing for nicks, chips, cracks, weld damage and other damage. Repair or replace if necessary.

(2) Inspect the ring gear for damaged or missing teeth. Replace if defective.

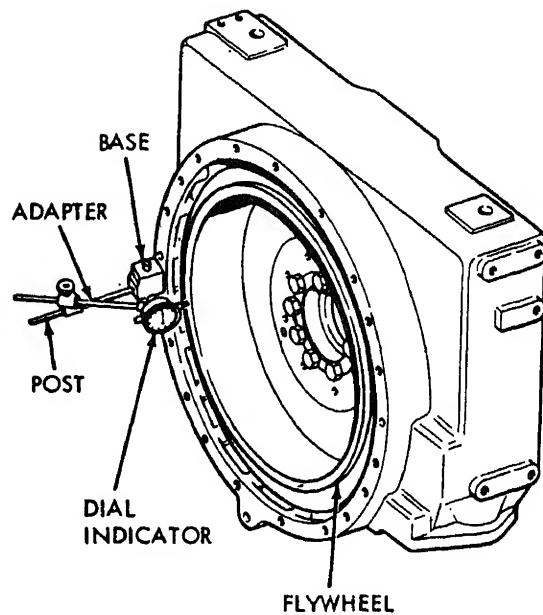
(3) Check the flywheel housing runout (subpara d) and flywheel runout (subpara e). Repair or replace as necessary.

**d. Checking Flywheel Housing Runout.** Mount a dial indicator to the flywheel housing as shown in figure 3-17. Total runout must not exceed 0.010 inch.



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18 and check the runout. Total runout must not exceed 0.006 inch.



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Figure 3-18. Checking flywheel runout.

**f. Reassembly and Installation.** (fig. 3-16.)

(1) Install a new mounting gasket (12) and the flywheel housing (11). Secure with locks (6, 7, 8, 9 and 10) and the retaining bolts (5). Tighten the bolts to a torque of 65 to 85 foot-pounds. Install the seal (13).

(2) Tighten the bolts which secure the oil pan and oil pan plate to the engine block and flywheel housing.

(3) If removed, heat the ring gear (3) to not more than 600° F and install on the flywheel (4). The chamfered side of the gear teeth should face the starter pinion when the flywheel is installed.

(4) Insert two  $\frac{5}{8}$  in. -18NF guide pins into the flywheel housing and install the flywheel (4). Secure with lock (2) and retaining bolts (1). Tighten the retaining bolts to a torque of 130 to 170 foot-pounds.

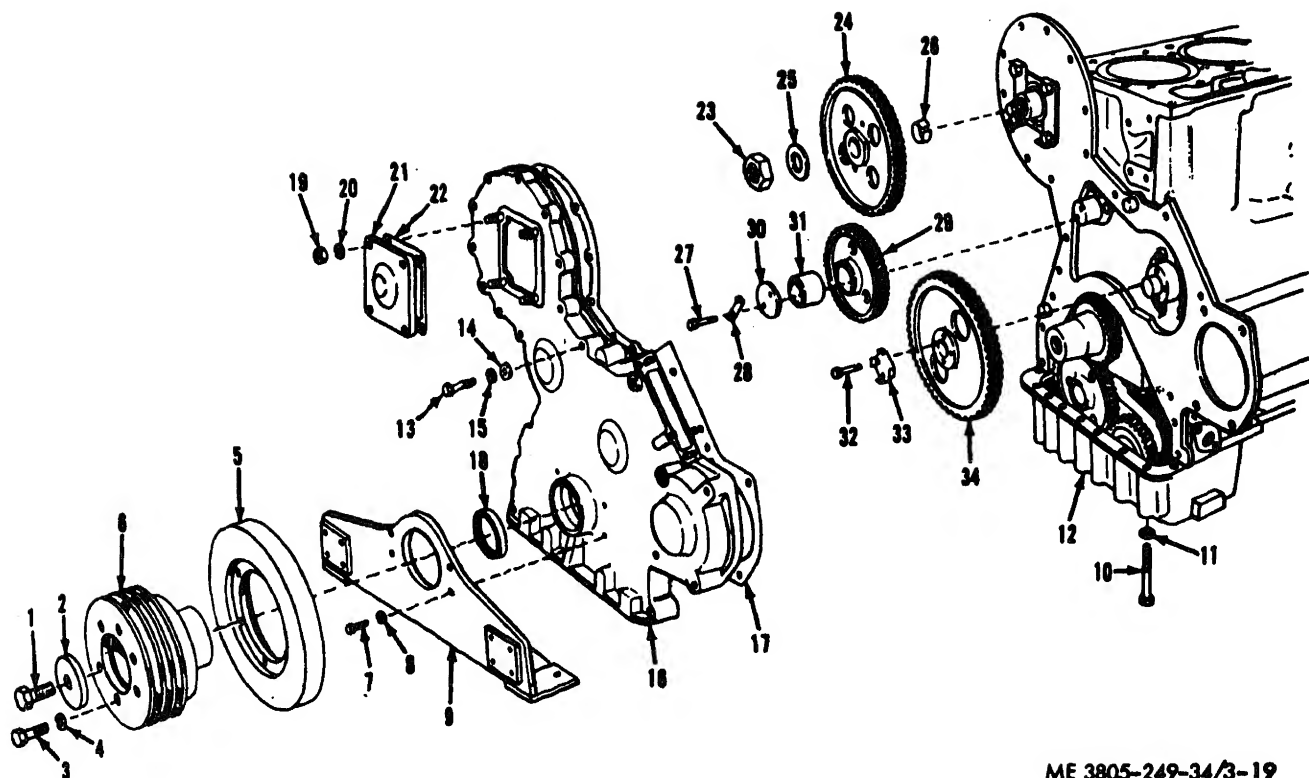
(5) Install the starting motor. Refer to TM5-3805-249-12.

(6) Install the engine in the grader (para 2-7).

**3-18. Timing Gears and Cover**



turns.



ME 3805-249-34/3-19

1. Bolt
2. Washer
3. Bolt
4. Lockwasher
5. Vibration damper
6. Pulley
7. Bolt
8. Lockwasher
9. Support
10. Bolt
11. Lockwasher
12. Oil pan
13. Bolt
14. Washer
15. Lockwasher
16. Timing gear cover
17. Gasket

18. Seal
19. Nut
20. Washer
21. Cover
22. Gasket
23. Nut
24. Accessory drive gear
25. Washer
26. Retainer
27. Bolt
28. Lock
29. Accessory drive idler gear
30. Plate
31. Spacer
32. Bolt
33. Lock
34. Camshaft gear

Figure 3-19. Timing gears and cover, exploded view.

(5) Remove the bolt (1) and washer (2) and remove the pulley assembly. Remove six bolts (3) and lockwashers (4) and separate the vibration damper (5) from the pulley (6).

(6) Remove four bolts (7) and lockwashers (8) and remove the front support (9).

(7) Remove the bolts (10) and lockwashers (11) which secure the oil pan (12) to the timing gear cover (16) to the engine block and plate. Discard the mounting gasket (17).

knife or screwdriver, carefully separate the oil pan and gasket from the timing gear cover.

*Note.* If the engine is being supported by the oil pan, insert spacers between the oil pan plate and cylinder block.

(8) Remove the bolts (13), washers (14) and lockwashers (15) which secure the timing gear cover (16) to the engine block and plate. Discard the mounting gasket (17).

(9) Remove the seal (18) if it is to be replaced.

(10) Remove four nuts (19) and washers (20) and remove the cover (21) and gasket (22).

(11) Remove the accessory drive gear retaining nut (23). Pull the accessory drive gear (24) from the accessory drive shaft. Remove the washer (25) and retainer (26).

(12) Remove two bolts (27) and the lock (28) securing the accessory drive idler gear (29). Remove the accessory drive idler gear (29) and plate (30) and spacer (31).

(13) Remove four camshaft gear retaining bolts (32) and the lock (33). Pull the camshaft gear (34) from the camshaft.

*b. Cleaning.* Clean all components in solvent. Dry with compressed air or with soft, lint-free cloths.

*c. Inspection and Repair.*

(1) Inspect the timing gear cover for chips, cracks, and other damage and for distortion. Repair as required.

(2) Inspect the timing gears for broken or missing teeth, excessive or uneven wear and cracks, chips and other damage. Repair or replace as required.

(3) Inspect the seal (item 18, fig. 3-19) for damage and deterioration and replace if necessary.

(4) Inspect the crankshaft pulley and vibration damper for damage and wear. Repair or replace as required.

*d. Reassembly and Installation.* (fig. 3-19.)

(1) Heat the camshaft gear (34) and install on the camshaft. Align the timing marks (subpara e). Secure with four camshaft gear retaining bolts (32) and the lock (33). Check the gear backlash (subpara f).

(2) Install the plate (30), spacer (31) and accessory drive idler gear (29). Secure with two bolts (27) and locks (28).

(3) Install the washer (25), retainer (26) and the accessory drive gear (24) on the accessory drive shaft. Aline the timing mark on the gear with the timing mark on the idler gear (28). Refer to subparagraph e. Install the retaining nut (23) and tighten to a torque of 90 to 110 foot-pounds.

(4) Install a new mounting gasket (17). Install the timing gear cover (16) to the engine block and plate, and secure with bolts (13), washers (14) and lockwashers (15).

(5) Install the bolts (10) and lockwashers (11) which secure the oil pan (12) to the timing gear cover. Tighten the remaining bolts which secure the oil pan to the cylinder.

(6) Install a new seal (18) in the timing gear

(8) Press on the pulley (6) and secure with the bolt (1) and washer (2). Tighten the bolt to a torque of 210 to 250 foot-pounds. Tap the pulley with a soft hammer and retighten to the same torque.

(9) Install the vibration damper (5) to the pulley (6) and secure with six bolts (3) and lockwashers (4).

(10) Install the cover (21) and a new gasket (22) and secure with four nuts (19) and washers (20).

(11) Install the water pump, fan belts and alternator as instructed in TM5-3805-249-12.

(12) Install the engine (para 2-7).

*e. Timing Mark Alinement.*

(1) Remove the timing gear cover (subpara a. above).

(2) Rotate the crankshaft in the direction of engine rotation until the No. 1 piston is at top dead center on the compression stroke and the timing marks are matched. Refer to figure 3-20.

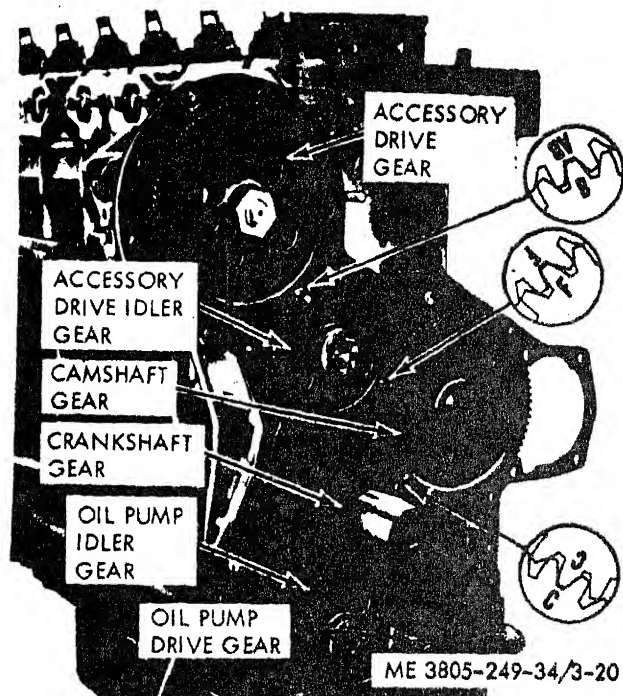


Figure 3-20. Timing gears and marks.

(3) If the timing marks are not properly alined, remove and reinstall the gears as necessary.

*f. Checking Camshaft Gear Backlash.*

(1) Check the backlash between the camshaft gear and the crankshaft gear by installing a dial indicator. Backlash should be 0.001 to 0.010 inch.

adjusting the fuel injection pump lifters (para 3-16).

(4) If the backlash measurement is low, check for a burr or rough spot on one of the gears and smooth as required.

### **3-19. Cylinder Head and Valve Mechanisms**

#### **a. Removal and Disassembly. (fig. 3-21.)**

(1) Drain the engine coolant. Refer to TM5-3805-249-12.

(2) Remove the exhaust pipe and manifold, air cleaner, breather, and hood. Refer to TM5-3805-249-12.

(3) Remove the fuel injection lines. Cap or plug openings.

(4) Remove the glow plugs.

(5) Steam-clean the engine.

(6) Remove the rocker arm cover.

(7) Loosen the rocker arm adjusting screw locknut (3) from each of the rocker arms. Back off the adjusting screws (4) one or two turns.

(8) Remove the bolt (1) and washer (2) from each rocker arm bracket. Carefully pry the rocker arm assembly from the cylinder head.

*Note.* Tag rocker arm components for proper installation. Do not mix parts from one assembly to another.

(9) Disassemble the rocker arms as follows:

(a) Remove the locknut (3) and adjusting screw (4).

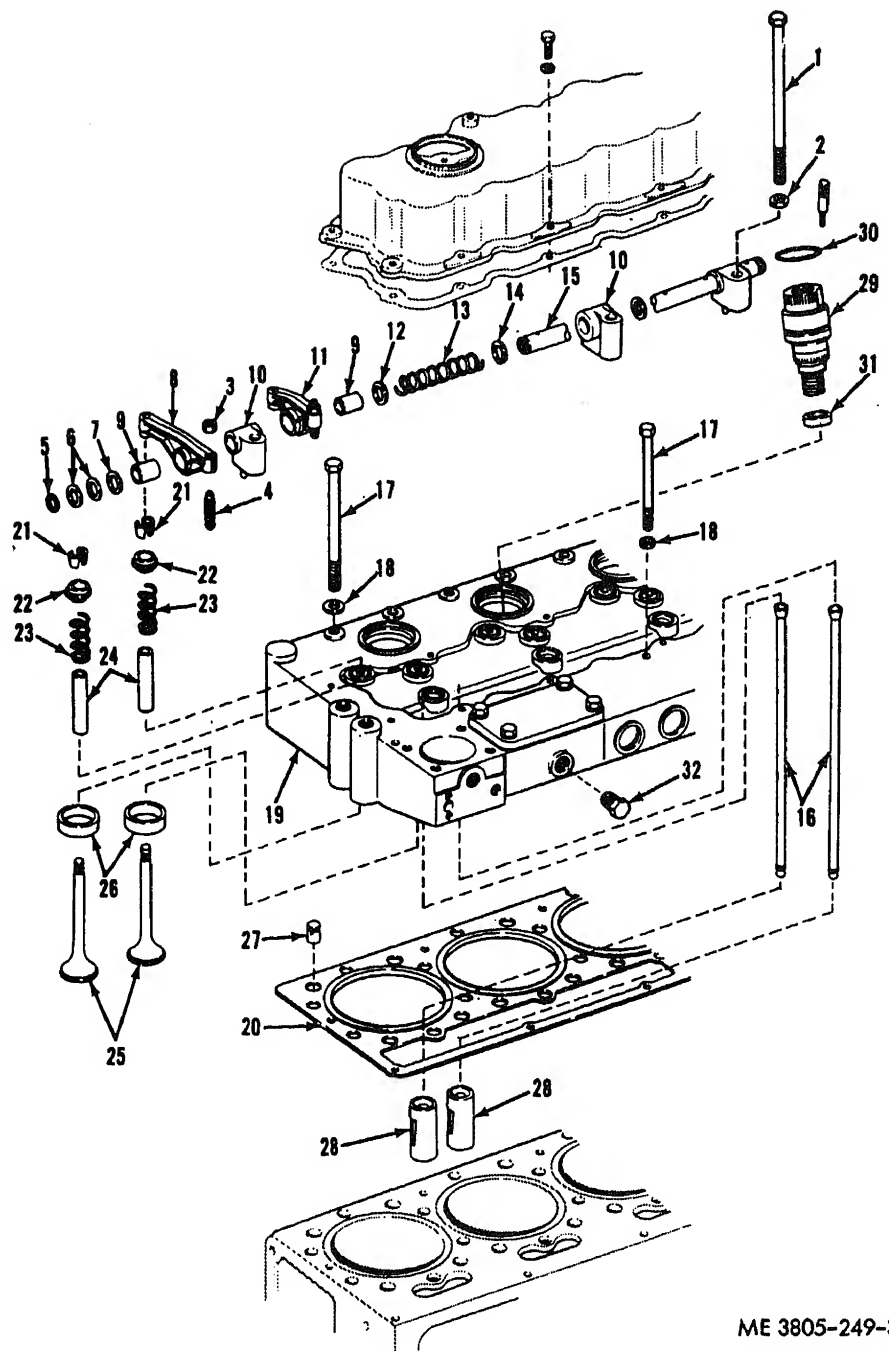
(b) Remove the ring (5), washer (6) and spring (7).

(c) Remove the rocker arm (8) and pull the bushing (9).

(d) Remove the bracket (10), rocker arm (11), washer (12), spring (13) and washer (14) from the rocker arm shaft (15).

(10) Remove the push rods (16) and tag them for proper installation.

(11) Remove the cylinder head bolts (17) and washers (18).



ME 3805-249-34/3

1. Bolt
2. Washer
3. Locknut
4. Adjusting screw
5. Ring
6. Washer
7. Spring
8. Rocker arm
9. Bushing
10. Bracket
11. Rocker arm

17. Bolt
18. Washer
19. Cylinder head
20. Gasket
21. Retainer
22. Retainer
23. Spring
24. Guide
25. Valve
26. Seat
27. Dowel

(12) Install two  $\frac{3}{4}$  in. -10NC forged eyebolts and attach a hoist to the cylinder head (19). Remove from the grader. Discard the cylinder head gasket (20).

(13) Using a spring compressor, compress the springs (23). Remove the retainers (21). Release the spring compressor and remove the retainers (22), springs (23) and guides (24).

(14) Remove the valves (25) and valve seats (26). Remove the locating dowels (27).

(15) Using a wire about 15 inches long with a hook at one end, remove the valve lifters (28) from the block.

(16) Remove the precombustion chambers (29) and seals (30 and 31).

(17) Remove the plug (32) from the cylinder head.

*b. Cleaning.* Remove all traces of carbon and other deposits with a clean cloth dampened with solvent. Blow out oil passages with compressed air.

*c. Inspection and Repair.*

(1) Inspect the rocker arm shaft for scoring or wear. If the shaft has been damaged by rocker arm movement, replace the shaft.

(2) Check rocker arm bushings for scratches, pitting or scoring. Replace the bushings if damaged.

(3) Place each rocker arm in position on the shaft. The rocker arm must rest freely on the shaft without side wobble. If wobble exists, replace the rocker arm.

(4) Inspect the springs for cracks and weakness. Replace springs as necessary.

(5) Inspect the cylinder head for fretting, erosion and warping in excess of 0.005 inch. Resurface the head if necessary.

(6) Inspect the push rods for straightness, cracks and worn ends. Replace if bent.

(7) Using a micrometer, measure the valve guide inner diameter. The diameter should be 0.3736 to 0.3756 inch and must not exceed 0.3766 inch. Replace if wear is excessive.

(8) Inspect and repair the valves as follows:

(a) Inspect the valves for damage. If the valve faces are pitted or do not properly contact the valve seats, reface the valves. Ensure that there is enough metal on the head of the valve to prevent dishing. Replace the valves if they are excessively damaged or worn.

(b) Using a micrometer, measure the valve stem diameter at three places. Diameter must not be less than 0.3702 inch at any point.

*Caution:* While handling valves, be

(2) Coat the chamfered portion of the cylinder head and the rubber seals (30) with liquid soap. Install the precombustion chambers in the cylinder head and tighten to a torque of 140 to 160 foot-pounds.

(3) Install the dowels (27) in the block. Install a new gasket (20). Install the plug (32).

(4) Install the valve lifters (28).

(5) Press the valve guides (24) into the cylinder head using an arbor. Resurface the valve seats after installing in the cylinder head. Lap valves and seats together to obtain a proper seal.

(6) Shrink the valve seats (26) in dry ice and install in the head. Drive into place with a suitable driver.

(7) Lubricate the valves (25) with clean engine oil and install.

(8) Install the valve springs (23) and retainers (22). Compress the springs and install the retainers (21).

(9) Coat the push rods (16) with clean engine oil and install in the block.

(10) Install the cylinder head (19) and secure with the washers (18) and bolts (17). Coat the threads of the bolts with a sealant. Refer to figure 3-22 and tighten as follows:

(a) *Step 1.* Tighten bolts in numerical order to 115 foot-pounds.

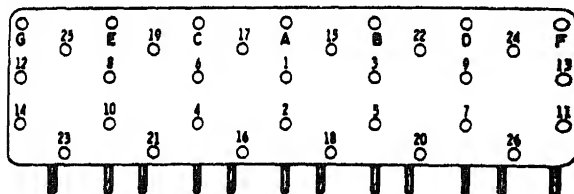
(b) *Step 2.* Retighten bolts in numerical order to 170 to 180 foot-pounds.

(c) *Step 3.* Retighten bolts in numerical order (hand torque only) to 170 to 180 foot-pounds.

(d) *Step 4.* Tighten bolts in alphabetical order to 22 foot-pounds.

(e) *Step 5.* Retighten bolts in alphabetical order to 27 to 37 foot-pounds.

(f) *Step 6.* Retighten bolts in alphabetical order (hand torque only) to 27 to 37 foot-pounds.



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Figure 3-22. Cylinder head bolts torque

TM5-3805-249-12 and tighten the adjusting screw locknut (3).

(14) Install the glow plugs and the fuel injection lines.

(15) Install the hood, breather, air cleaner, exhaust pipe and exhaust manifold: Refer to TM5-3805-249-12.

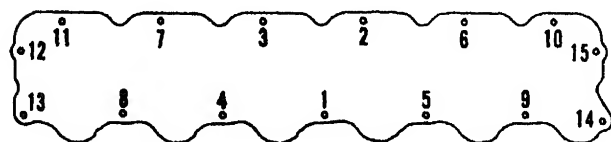
(16) Service the cooling system as instructed in TM5-3805-249-12.

(17) Start the engine. Ensure that the rocker arms are receiving lubricating oil.

(18) Operate the engine for approximately one hour (under load if possible) to thoroughly warm up the engine and seat the head gasket.

(19) Shut down the engine and retighten the cylinder head bolts. Check and readjust the valve lash.

(20) Install the rocker arm cover. Coat the mating surfaces of the cover and gasket with sealant. Tighten the retaining bolts in numerical order shown in figure 3-23 to a torque of 72 to 120 inch-pounds



ME 3805-249-34/3-23

Figure 3-23. Rocker arm cover bolts torque sequence.

### 3-20. Pistons, Connecting Rods and Cylinder Liners

#### a. Removal and Disassembly. (fig. 3-24.)

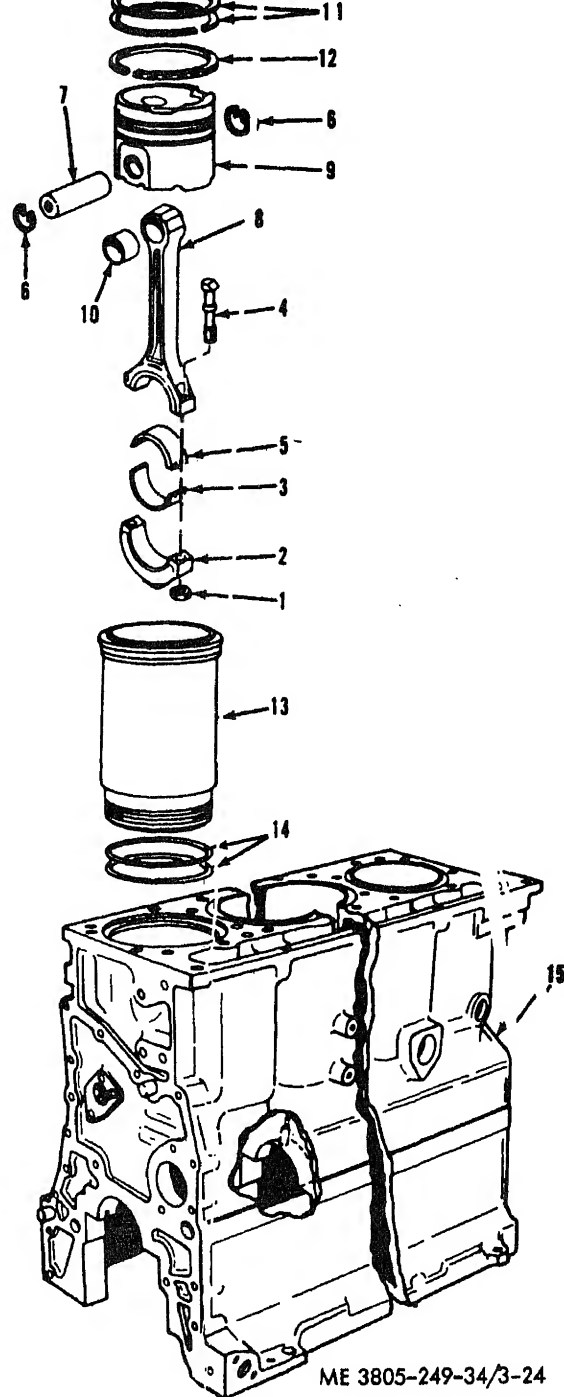
(1) Drain the engine lubricating oil and coolant. Refer to TM5-3805-249-12.

(2) Remove the cylinder head and valves (para 3-19).

(3) Remove carbon deposits from the inside top surfaces of the cylinder liner.

(4) Remove the cylinder block inspection covers or the oil pan to gain access to the connecting rod bearings (3 and 5). Turn the crankshaft until the nuts (1) are accessible.

(5) Remove the nuts (1) from the bolts (4) and remove the cap (2) and bearing lower half (3). Rotate the crankshaft and remove the bolts (4) and upper bearing half (5).



- |                       |                 |
|-----------------------|-----------------|
| 1. Nut                | 9. Piston       |
| 2. Cap                | 10. Bearing     |
| 3. Bearing lower half | 11. Piston ring |
| 4. Bolt               | 12. Piston ring |
| 5. Bearing upper half | 13. Liner       |
| 6. Retaining ring     | 14. Ring        |
| 7. Piston pin         | 15. Block       |
| 8. Connecting rod     |                 |

Figure 3-24. Piston and connecting rod, exploded view.

(6) Rotate the crankshaft to place the piston to be removed at top dead center. Push the connecting rod upward until the piston rings are out of the cylinder. Lift out the piston and connecting rod assembly.

(7) Remove the piston pin retaining rings (6) from the piston pin (7) and press out the piston pin. Separate the connecting rod (8) from the piston (9). Remove the bearing (10) from the connecting rod (8) if replacement is necessary.

(8) Using a piston ring expander, remove the piston rings (11 and 12) from the piston (9).

**Caution:** Cover the crankshaft and main bearings before removing the liners. Sediment from the block could damage the crankshaft and bearings.

(9) Using a liner puller assembly and an adapter plate, remove the liner (13) from the block (15). Discard the rings (14).

b. *Cleaning.* Clean all components with solvent and dry with clean, lint-free cloths.

c. *Inspection and Repair.*

(1) Inspect connecting rod bearings for burrs and rough spots. Light scratching will not impair operation. Smooth minor roughness with a soft hone or crocus cloth. Replace very rough bearings. If one bearing must be replaced, replace all bearings if possible.

(2) Replace bent connecting rods.

(3) Press the piston pin into position into the bearing. Measure the clearance. Replace the pin and bearing if clearance exceeds 0.004 inch.

(4) Inspect the piston pin for cracks, score marks or pitting. Discard the pin if surfaces are dull, rough or checked by acid corrosion.

(5) Inspect the bearing liners for wear, scratches, pitting and metal failure. Replace as required.

(6) Inspect the piston for grooves, scoring, pitting and other damage and for wear. Replace piston if surface damage is excessive.

(7) Inspect the cylinder liner for scratches, scoring, grooving and wear. Measure the inside diameter using a micrometer. Replace the sleeve if diameter exceeds 4.758 inch at any point.

d. *Reassembly and Installation.* (fig. 3-24.)

(1) Ensure that the engine block is clean.

(2) Install new rings (14) on the cylinder liner (13).

(3) Carefully lower the liner into the cylinder block. Drive into place until the liner bottoms.

**Note.** The liner should protrude 0.0020 to 0.0056 inch above the face of the cylinder block.

(4) Press the bearing (10) into place in the connecting rod (8). Numbered side of connecting rod will be directly below the "V" notch in the crown. Secure the piston (9) to the connecting rod using the piston pin (7). Install the remaining rings (6).

(5) Using a piston ring expander, install the piston rings (11 and 12) in their grooves. Install the middle ring with the "TOP" mark up.

(6) Oil the piston and rings. Place the piston and connecting rod assembly in the cylinder liner. Use a piston ring compressor to aid in installation. Position the V-mark on top of the piston so that it is aligned with the V-mark on the block.

(7) Install the bearing upper half (5), bearing lower half (3) and cap (2). Secure with bolt (4) and nut (1). Lubricate the threads with crankcase oil and tighten to a torque of 27 to 33 foot-pounds. Then tighten an additional 85 to 95 degrees.

(8) Install the cylinder block inspection covers or the oil pan, if removed.

(9) Install the cylinder head and valves (para 3-19).

(10) Service the engine lubricating system and cooling system. Refer to TM5-3805-249-12.

### 3-21. Crankshaft and Main Bearings

#### a. *Removal and Disassembly.*

(1) Remove the engine from the grader. Refer to paragraph 2-7. Place the engine on a suitable work stand.

(2) Remove the water pump as instructed in TM5-3805-249-12. Remove the timing gear cover (para 3-18) and the flywheel and housing (para 3-17).

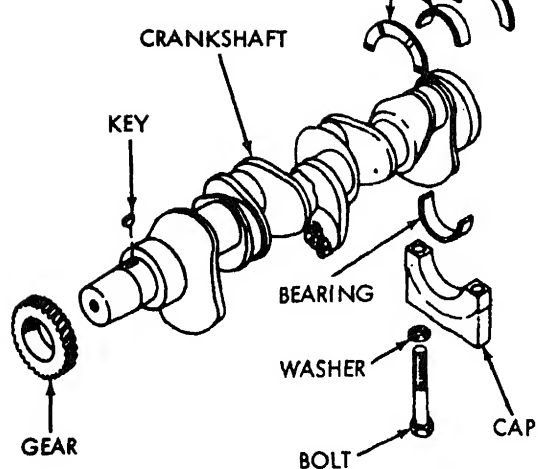
(3) Place the engine on its side and remove the oil pan and oil pan plate (para 3-15) and the oil pump (para 3-14).

(4) Remove the connecting rod bearings and caps (para 3-20). Push the piston and rod assemblies upward into the cylinders to clear the crankshaft.

(5) Wrap a heavy cloth around the number two and five connecting rod bearing surfaces on the crankshaft.

(6) Place a cable around the cloth and attach a hoist to the cable. Tighten the cable just enough to prevent the crankshaft from moving when the main bearing caps are removed.

(7) Remove the bolts and washers that secure the bearing caps to the block. Refer to figure 3-25.



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Figure 3-25. Crankshaft and main bearings.

(8) Grasp the bearing cap at the recessed portion and pull outward. Tap the cap lightly with a soft hammer to aid in removal.

*Note.* Mark the upper and lower bearing caps for location.

(9) Remove the main bearing upper halves using the locally-fabricated tool shown in figure 2-2.

(10) Place the tool in the drilled oil hole. Rotate the crankshaft and roll out the bearing upper half. Roll out the bearing tab end first. Remove the bearing lower half from the bearing cap.

(11) Cover the bearing cap studs with rubber hose or cloth to protect the crankshaft when it is removed.

(12) Lift the crankshaft from the engine. Lubricate and wrap the bearing surfaces.

(13) Using a hydraulic puller, pull out the crankshaft gear from the crankshaft. Remove the key.

**b. Cleaning.** Clean the crankshaft with solvent and dry with clean, lint-free cloths. Clean the oil holes in the block and ensure that the block is clean. Clean bearings as instructed in paragraph 2-6.

**c. Inspection and Repair.**

(1) Inspect the bearing caps for burrs and high spots. Smooth surfaces with a soft hone or crocus cloth. Scratches on the bearing surfaces will not impair operation. Replace bearings if the surface is excessively rough and abrasive. If one bearing is replaced, replace all bearings if possible.

(2) Check the main bearing journals with a

micrometer. Grind the journals undersize 0.030 inch. At installation use undersize main and connecting rod bearings.

(3) After grinding, clean the crankshaft thoroughly. Check for runout with a dial indicator. If crankshaft runout exceeds 0.008 inch, replace the crankshaft.

(4) Inspect the crankshaft gear for cracks, broken teeth, burrs, scoring and wear. Remove burrs and light scoring with a soft hone or crocus cloth or replace the gear if necessary.

**d. Reassembly.**

(1) Position the key in the crankshaft. Using a hydraulic pump, press the crankshaft gear onto the crankshaft.

(2) Install the crankshaft in the block. Aline the crankshaft gear as instructed in paragraph 3-18.

(3) Install the bearing inserts and lubricate the inside surfaces of the bearings. Rotate the upper bearings into position in the reverse order of removal. Ensure that bearings are installed in the same positions they were removed from.

(4) Install the lower bearing caps and secure with nuts. Tighten the nuts to a torque of 155 foot-pounds.

(5) Check the bearing clearance (subpara e) and the crankshaft end clearance (subpara f).

(6) Install the oil pump (para 3-14) and oil pan and oil pan plate (para 3-15). Install the flywheel and housing (para 3-17) and timing gear cover (para 3-18). Install the water pump as instructed in TM5-3805-249-12.

(7) Install the engine in the grader (para 2-7).

**e. Main Bearing Clearance Check.**

*Note.* If bearing clearance is checked while the crankshaft is installed and the engine is upright, hold the crankshaft against the upper halves of the bearings.

(1) Place a soft lead wire between the lower bearing half and the crankshaft. Coat two 1-inch lengths of the wire with grease and place them diagonally on the bearing. The grease will hold the wires in position.

(2) Turn the crankshaft one complete revolution.

(2) Remove the bearing cap and measure the thickness of the compressed wire using a micrometer. Clearance should be 0.0030 to 0.0059 inch. Replace bearings if the proper clearance is not obtained.

**f. Crankshaft End Clearance Check.**

(1) Push the crankshaft as far as it will go to one end of the cylinder block.



the rear main bearing. End clearance should be 0.0025 to 0.0145 inch.

### 3-22. Camshaft

#### a. Removal and Disassembly. (fig. 3-26.)

- (1) Remove the engine from the grader (para 2-7).
- (2) Remove the pushrods (para 3-19) and lift the valve lifters clear of the camshaft.
- (3) Remove the timing gear cover (para 3-18).
- (4) Remove two bolts and the washer and pull the camshaft and camshaft gear from the block. Be careful not to damage the camshaft bearings.

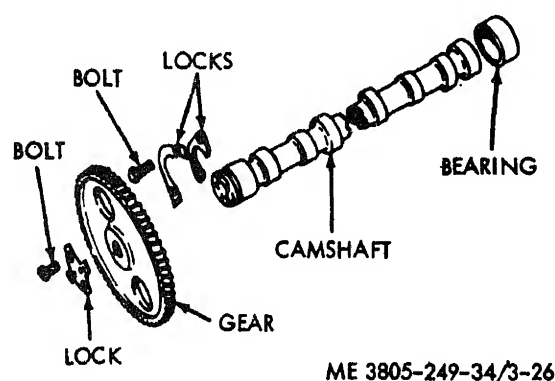


Figure 3-26. Camshaft assembly, exploded view.

- (5) Remove four bolts and the lock and pull the gear from the camshaft.
- (6) Remove the flywheel housing (para 3-17). Press the bearings out of the block.

#### b. Cleaning.

(1) Clean the camshaft thoroughly with solvent. Blow out the oil holes with compressed air. Dry with clean, lint-free cloths or with compressed air.

(2) Clean bearings as instructed in paragraph 2-6.

#### c. Inspection and Repair.

(1) Using a magnetic particle technique, inspect the camshaft for cracks. Replace if any cracks are detected.

(2) Inspect the camshaft for roughness, scoring, scratches, grooves or wear. Replace if worn or damaged. Measure the camshaft bearing surfaces using a micrometer. If any diameter is less than 1.40 inches, replace the camshaft.

(3) Inspect the camshaft bearings for wear and surface damage. Repair if possible or replace bearings as required.

(4) Inspect the camshaft gear for broken teeth.

(1) Install the camshaft bearings in the cylinder block. Align the oil holes in the front bearing with the oil hole in the block. Install the front and rear bearings so that there is a  $\frac{1}{8}$ -inch clearance between the face of the cylinder block and the end of the bearing.

(2) Install the flywheel housing (para 3-17).

(3) Install the gear to the camshaft. Secure with the lock and four bolts.

(4) Install the camshaft and camshaft gear in the block and secure with the washers and two bolts.

(5) Check the camshaft gears backlash (para 3-18).

(6) Check the camshaft end clearance (sub-para e).

(7) Install the timing gear cover (para 3-18) and the pushrods (para 3-19).

(8) Install the engine in the grader (para 2-7).

#### e. Checking Camshaft End Clearance.

(1) Push the washer forward against the camshaft gear.

(2) Using a thickness gage, measure the distance between the washer and the end of the camshaft bearing journal. The clearance should be 0.004 to 0.010 inch and must not exceed 0.025 inch.

### 3-23. Cylinder Block

#### a. Removal and Disassembly.

(1) Remove the engine from the grader (para 2-7).

(2) Remove the water pump, alternator and transfer fuel pump. Refer to TM5-3805-249-12.

(3) Remove the fuel injection pump (para 3-6), transmission oil cooler (para 4-5), oil pump (para 3-14) and oil pan and oil pan plate (para 3-15).

(4) Remove the timing gears and cover (para 3-18), flywheel and flywheel housing (para 3-17), cylinder head and valves (para 3-19), pistons, connecting rods and cylinder liners (para 3-20), crankshaft (para 3-21) and camshaft (para 3-22).

(5) Remove the inspection covers from the block.

b. *Cleaning.* Steam-clean the block. Wipe with a cloth dampened with solvent. Remove all corrosion and scale from water jackets and passages using high pressure water and steam. Flush oil passages with water and dry with compressed air.

#### c. Inspection and Repair.

(1) Inspect threaded holes for damage. Chase with a tap or die if damaged.

(2) Inspect the block thoroughly for cracks, wears, signs of strain or other damage. Replace

block if damage cannot be repaired by welding or minor machining.

(3) Inspect gasket surfaces for warpage, nicks or burrs. Smooth by grinding. Replace block if excessively warped.

*d. Reassembly and Installation.* Assemble the engine in the reverse order of disassembly. Install in the grader (para 2-7).



## CHAPTER 4

# REPAIR OF DRIVE TRAIN COMPONENTS

### Section I. POWERSHIFT TRANSMISSION

#### 4-1. General

The hydraulic transmission system consists of the flywheel clutch, range transmission, transmission and scavenge oil pump, oil filter, hydraulic control, breathers and strainers, and controls and linkages. The flywheel clutch is housed in the case which houses the transfer gear and bevel gears. The housing forms a bell case with the engine flywheel housing at the rear side and serves as a mount for the transmission housing at the forward side. Power flow is from the diesel engine to the flywheel clutch, through the transmission to the transfer gears and bevel gears, and to the final drives and axles. Refer to figure 4-1 for the drive train installation diagram.

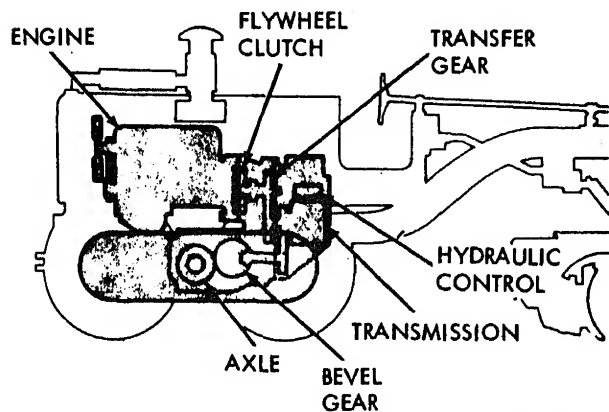
#### 4-2. Flywheel Clutch

**a. Removal.** The flywheel clutch is housed partly in the engine flywheel housing and partly in the transfer gear housing. It is not removed as a separate unit. To gain access to the flywheel clutch, remove the engine.

**b. Disassembly.** (fig. 4-2.)

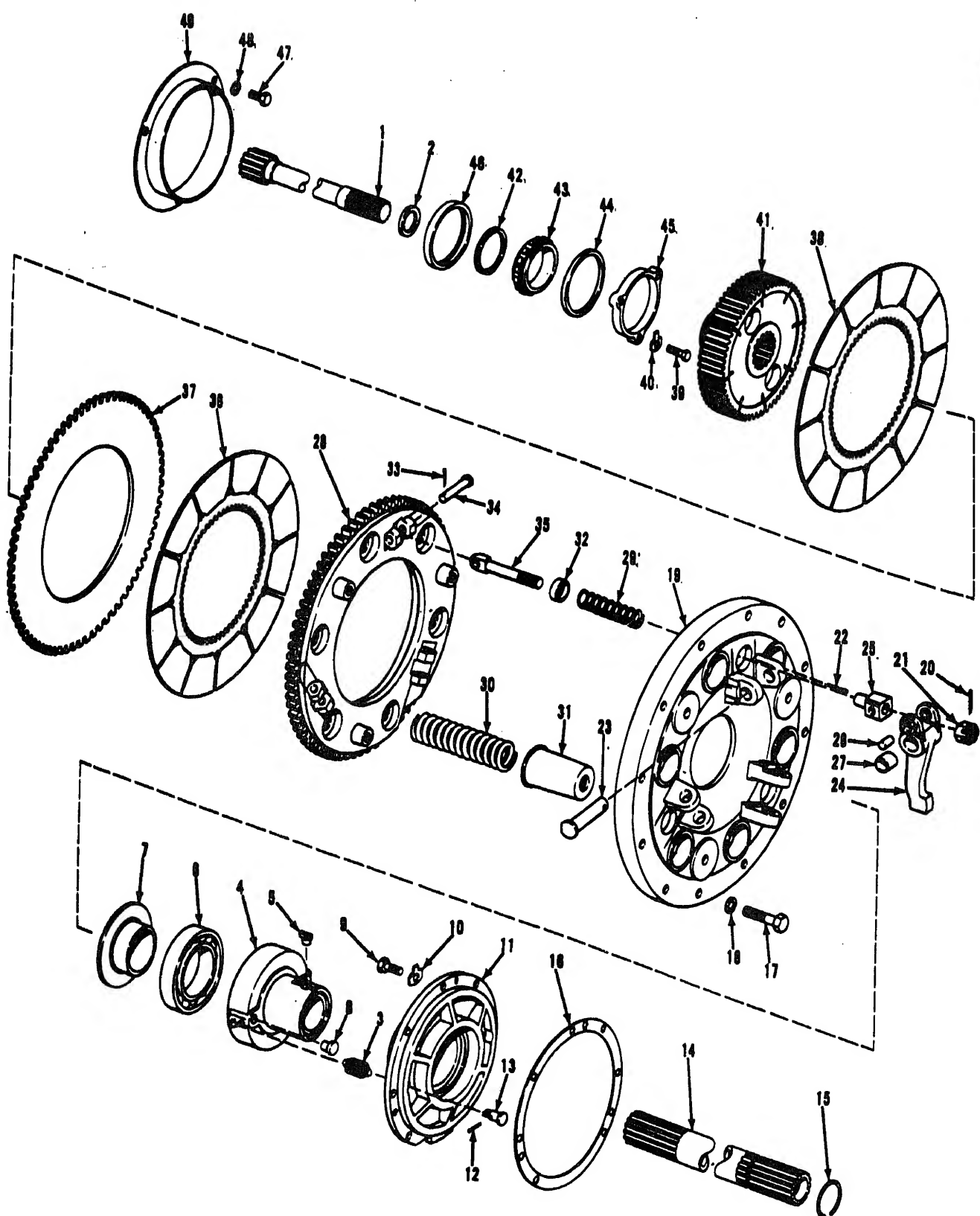
**Note.** The flywheel clutch cannot be disassembled unless the engine is removed from the grader. When the flywheel housing is separated from the transfer gear housing, items 1 through 16, figure 4-2, remain with the transfer gear housing and items 17 through 49 remain with the engine.

(1) Remove the shaft (1) and washer (2) from the transfer gear housing. Disconnect two springs (3).



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Figure 4-1. Drive train installation diagram.



(2) Remove the bearing cage (4) and key (5). Remove the bearing (6) and thrust ring (7) using a hammer and punch. Remove the two buttons (8) from the bearing cage (4). Using appropriate pullers, remove the thrust ring (7) from the bearing (6).

(3) Remove the bolts (9), locks (10) and the plate (11). Remove the cotter pins (12) and pins (13) and remove the springs (3).

(4) Remove the drive shaft (14), retaining ring (15) and gasket (16).

(5) At the flywheel housing, remove all but three of the bolts (17) and lockwashers (18). Install two ½ in. -13NC guide pins (8 inches long) through the clutch cover plate (19) and into the flywheel. Remove the remaining bolts (17) and lockwashers (18).

(6) Remove the clutch cover plate (19). Disassemble as follows:

(a) Remove the cotter pin (20), nut (21), cotter pin (22) and pin (23).

(b) Remove the lever (24) and block (25).

(c) Remove the bearings (26 and 27) from the lever.

(d) Separate the pressure plate (28) from the cover plate (19).

(e) Remove the springs (29 and 30), spring covers (31), ring (32), cotter pin (33), pin (34) and bolt (35) from the pressure plate.

(7) Remove the discs (36, 37 and 38) from the flywheel housing.

(8) Turn the hub (41) so that the bolts (39) are accessible. Remove the bolts (39), locks (40) and the hub (41).

(9) Remove the lock ring (42), roller (43),

retainer ring (44) and lock ring (45) from the hub (41).

(10) Using a puller, pull the outer race (46) from the flywheel.

(11) Remove the bolts (47) and lockwashers (48) and remove the oil thrower (49).

*c. Cleaning.* Clean all components except bearings with solvent and dry with compressed air. Clean bearings as instructed in paragraph 2-6.

*d. Inspection and Repair.*

(1) Inspect all parts for cracks, fatigue lines, nicks, scratches, burrs, wear and other damage.

(2) Inspect gears for chipped or broken teeth and for wear.

(3) Inspect bearings for wear, nicks, scratches, pitting and other damage to the bearings and races.

(4) Remove burrs, scratches and light scoring from machined surfaces with a soft honing stone or crocus cloth.

(5) Replace any damaged or excessively worn parts. Replace worn or damaged bearings.

*e. Reassembly.* Assemble the flywheel clutch in the reverse order of disassembly.

#### 4-3. Transmission Oil Pump

*a. Removal.*

(1) Remove the seat assembly (para 9-2).

(2) Remove bolts and lockwashers and remove the right side of the battery access.

(3) Remove the oil tubes from the pump. Cap or plug openings.

(4) Remove bolts and lockwashers and remove the oil pump (item 19, fig. 4-7).

*b. Disassembly.* (fig. 4-3.)

(1) Remove four bolts and washers (1) and remove the cover (2). Remove the oil seal (3).

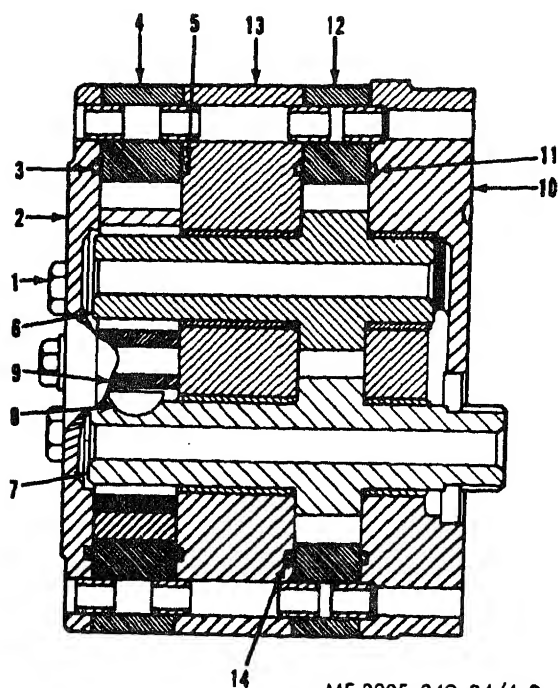
(2) Remove the scavenge section body (4) and the oil seal (5).

(3) Remove the scavenge section gears (6 and 7), key (8), and gear (9).

(4) Remove the base (10) and the oil seal (11).

#### KEY to fig 4-2:

1. Shaft	25. Block
2. Washer	26. Bearing
3. Spring	27. Bearing
4. Cage	28. Pressure plate
5. Key	29. Spring
6. Bearing	30. Spring
7. Thrust ring	31. Cover
8. Button	32. Ring
9. Bolt	33. Cotter pin
10. Lock	34. Pin
11. Plate	35. Bolt
12. Cotter pin	36. Disc
13. Pin	37. Disc
14. Shaft	38. Disc
15. Retaining ring	39. Bolt
16. Gasket	40. Lock
17. Bolt	41. Hub
18. Lockwasher	42. Lock ring
19. Oil pump	43. Roller
20. Cotter pin	44. Retainer ring
21. Nut	45. Lock ring
22. Cotter pin	46. Outer race
23. Pin	47. Bolt
24. Lever	48. Lockwasher
25. Block	49. Oil thrower



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- |                    |              |
|--------------------|--------------|
| 1. Bolt and washer | 8. Key       |
| 2. Cover           | 9. Gear      |
| 3. Seal            | 10. Base     |
| 4. Body            | 11. Seal     |
| 5. Seal            | 12. Body     |
| 6. Gear            | 13. Manifold |
| 7. Gear            | 14. Seal     |

Figure 4-3. Transmission oil pump, cross section.

(5) Separate the transmission section body (12) from the manifold (13) and remove the oil seal (14).

(6) Remove the bearings from the base (10) and manifold (13).

**c. Cleaning.** Clean all components except bearings in solvent and dry with compressed air. Clean bearings as instructed in paragraph 2-6.

**d. Inspection and Repair.**

(1) Inspect the gear housings for areas worn

down by the gears. Replace housings having wear in excess of 0.005 inch.

(2) Place a straightedge across the housing bores. If a 0.005 inch feeler gage can be slipped under the straightedge, replace the housing.

(3) Inspect gear teeth for scoring, grooving, burring, nicking and fretting. Inspect the gear hubs for wear detectable by touch or in excess of 0.002 inch. Replace or repair gears as necessary. Replace gears in pairs only.

(4) Inspect the seal areas for wear detectable by touch or in excess of 0.002 inch. Replace as necessary.

(5) Inspect bearings for scratches, nicks, pitting, scoring, flat spots and wear. Replace damaged or worn bearings. Also replace bearings whenever the gears are replaced.

(6) Replace damaged or deteriorated seals.

**e. Reassembly.** Assemble the pump in the reverse order of disassembly.

**f. Installation.** Fill the pump with clean oil and rotate the drive shaft. Install the pump in the reverse order of removal.

#### 4-4. Transmission Hydraulic Control

##### **a. Removal and Disassembly.**

**Note.** The transmission hydraulic control can be removed while the transmission is removed from or installed in the grader. If the transmission has been removed, proceed to (4), below.

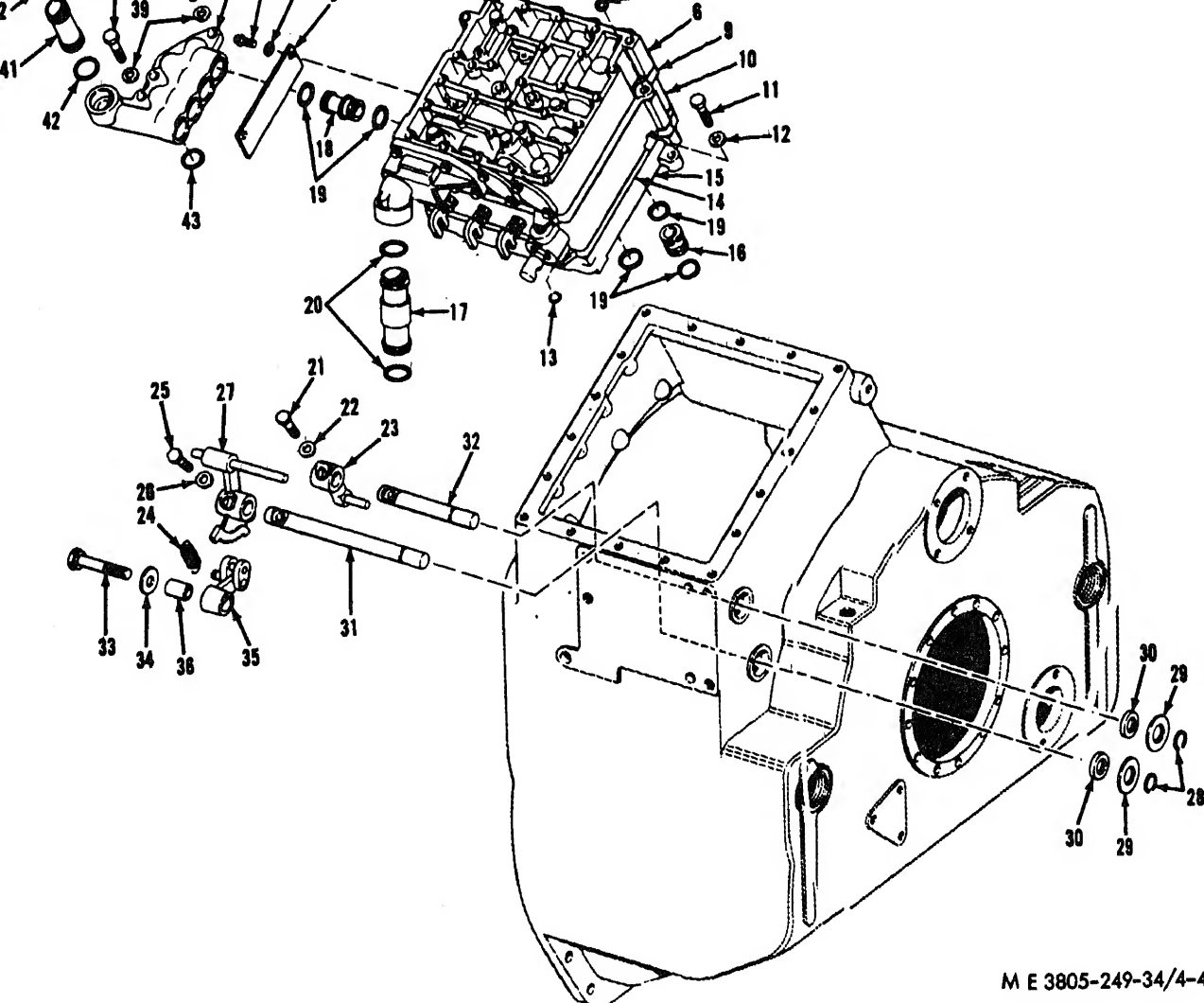
(1) Remove the seat assembly (para 9-2).

(2) Remove bolts and lockwashers and remove the plate from the right side of the battery access.

(3) Disconnect oil lines to the oil filter and oil cooler. Cap or plug openings.

(4) Remove the control access cover (item 60, fig. 4-7).

(5) Remove the bolts (1, fig. 4-4), washers (2) and retainer (3). Remove the bolts (4) and washers (5) and lift off the pressure control valve (6). Disassemble the valve as instructed in subparagraph b.



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1. Bolt
2. Washer
3. Retainer
4. Bolt
5. Washer
6. Pressure control valve
7. Bolt
8. Washer
9. Plate
10. Selector valve
11. Bolt
12. Washer
13. Retaining ring
14. Plate
15. Manifold
16. Tube
17. Tube
18. Tube
19. Packing
20. Packing
21. Bolt
22. Washer

23. Lever
24. Spring
25. Bolt
26. Washer
27. Lever
28. Retaining ring
29. Washer
30. Seal
31. Shaft
32. Shrift
33. Bolt
34. Washer
35. Lever
36. Bearing
37. Bolt
38. Bolt
39. Washer
40. Manifold
41. Tube
42. Packing
43. Packing

Figure 4-4. Transmission hydraulic control.



valve (10). Disassemble the selector valve (subpara b).

(7) Remove the bolts (11), washers (12), retaining rings (13), lower manifold plate (14) and manifold (15).

(8) Remove the tubes (16, 17 and 18) and packings (19 and 20). Be careful not to drop the packings into the transmission housing.

(9) Remove the bolt (21) and washer (22) securing the forward reverse inner lever (23) and remove the lever.

(10) Remove the spring (24) from the selector levers.

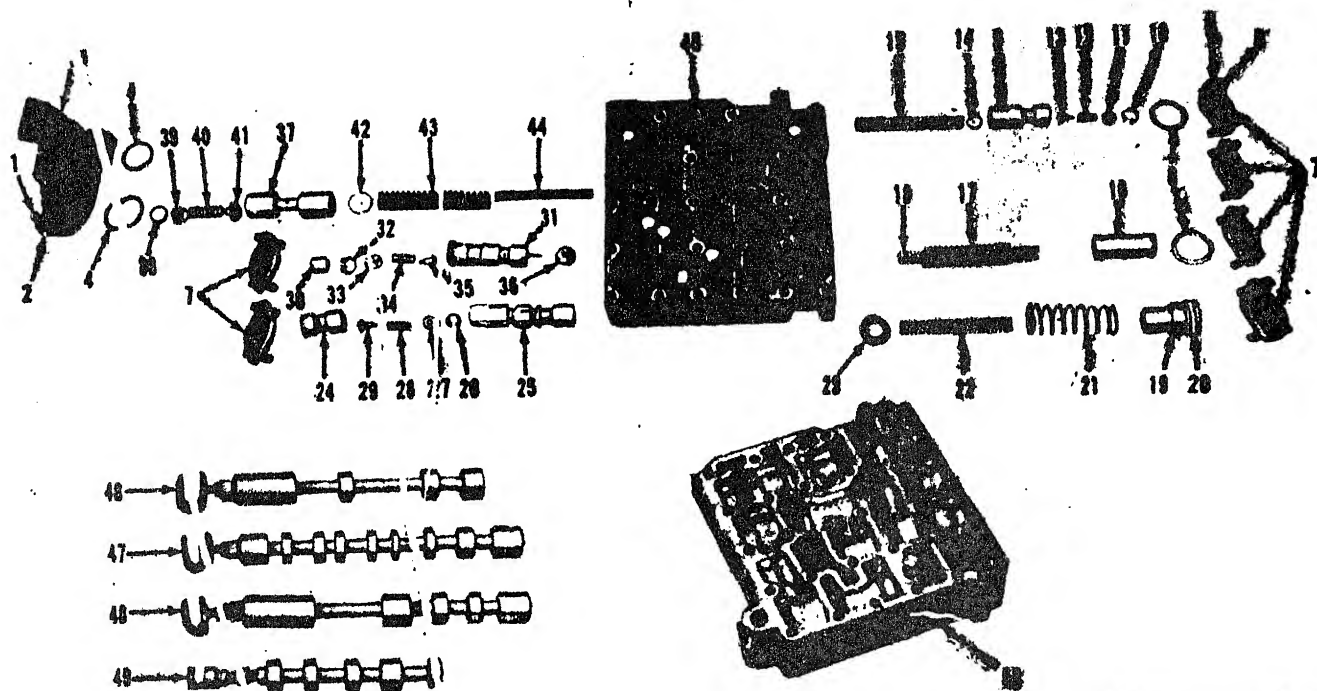
(11) Remove the bolt (25), washer (26) and inner selector lever (27).

(13) Remove the bolt (33), washer (34) and rear selector lever (35). Drive out the bearing (36).

(14) Remove the bolts (37 and 38), washers (39) and the manifold (40). Remove the tube (41) and packings (42 and 43). Be careful not to permit the packings to fall into the transmission housing.

*b. Disassembly of Control Valve and Selector Valve. (fig. 4-5.)*

(1) Remove the bolts (1) and washers (2) and remove the manifold (3) from the pressure control valve housing. Remove the packings (4).



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- |               |               |               |                            |
|---------------|---------------|---------------|----------------------------|
| 1. Bolt       | 14. Stop      | 27. Retainer  | 39. Retainer               |
| 2. Washer     | 15. Spring    | 28. Spring    | 40. Spring                 |
| 3. Manifold   | 16. Piston    | 29. Plunger   | 41. Ball                   |
| 4. Packing    | 17. Spring    | 30. Slug      | 42. Stop                   |
| 5. Bolt       | 18. Spring    | 31. Spool     | 43. Spring                 |
| 6. Washer     | 19. Stud      | 32. Snap ring | 44. Spring                 |
| 7. Cover      | 20. Seal      | 33. Retainer  | 45. Control valve housing  |
| 8. Packing    | 21. Spring    | 34. Spring    | 46. Spool                  |
| 9. Spool      | 22. Spring    | 35. Plunger   | 47. Spool                  |
| 10. Snap ring | 23. Washer    | 36. Stop      | 48. Spool                  |
| 11. Retainer  | 24. Stop      | 37. Spool     | 49. Spool                  |
| 12. Spring    | 25. Spool     | 38. Snap ring | 50. Selector valve housing |
| 13. Plunger   | 26. Snap ring |               |                            |

Figure 4-5. Transmission control valve and selector valve, exploded view.

(2) Remove the bolts (5) and washers (6) and remove the covers (7). Remove the packings (8).

(3) Remove the spool (9). Remove the snap ring (10), retainer (11), spring (12) and plunger (13) from the spool. Remove the stop (14) and spring (15).

(4) Remove the piston (16) and springs (17 and 18).

(5) Remove the plug (19) and seal (20). Remove the springs (21 and 22) and the washer (23).

(6) Remove the stop (24) and the spool (25). Remove the snap ring (26), retainer (27), spring (28) and plunger (29).

(7) Remove the slug (30) and the spool (31). Remove the snap ring (32), retainer (33), spring (34) and plunger (35). Remove the stop (36).

(8) Remove the spool (37). Remove the snap ring (38), retainer (39), spring (40) and ball (41) from the spool. Remove the stop (42) and springs (43 and 44) from the control valve housing (45).

(9) Remove the spools (46, 47, 48 and 49) from the selector valve housing (50).

*c. Cleaning.* Clean all components with solvent and dry with clean, lint-free cloths.

*d. Inspection and Repair.*

(1) Inspect the valve housings for nicks, burrs or pitting. Inspect the edges for wear caused by recirculating abrasive particles. Replace the housings if wear is excessive. Light scratches and grey wear spots will not impair valve operations.

(2) Inspect the spools for grooves, deep scratches and excessive wear. Ensure that the spools fit into their respective valve body bores with a slight hand pressure and without perceptible side clearance.

(3) Inspect the plungers and stops for ridges or scoring. Ensure that the valve orifices are open.

(4) Replace all springs, if required.

*e. Reassembly of Control Valve and Selector Valve.* Assemble the control valve and selector valve in the reverse order of disassembly. Tighten the cover retaining bolts (5, fig. 4-5) and manifold

pounds.

*f. Reassembly and Installation.* Assemble and install the hydraulic control in the reverse order of removal. Adjust the selector spools as required (subpara g).

*g. Spool Adjustment.* (fig. 4-6.)

(1) Bottom the detent in the selector valve spools in the No. 5 notch of the cam assembly.

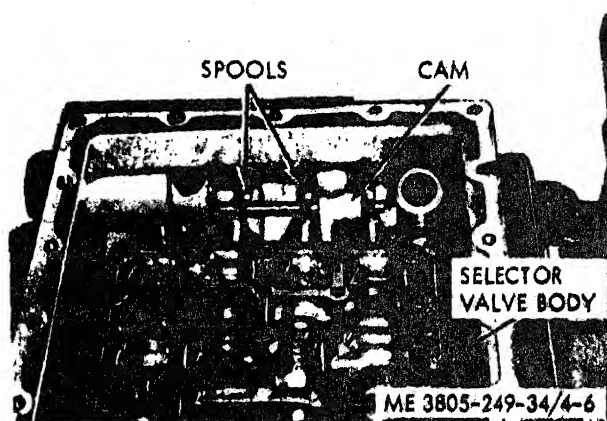


Figure 4-6. Spool adjustment.

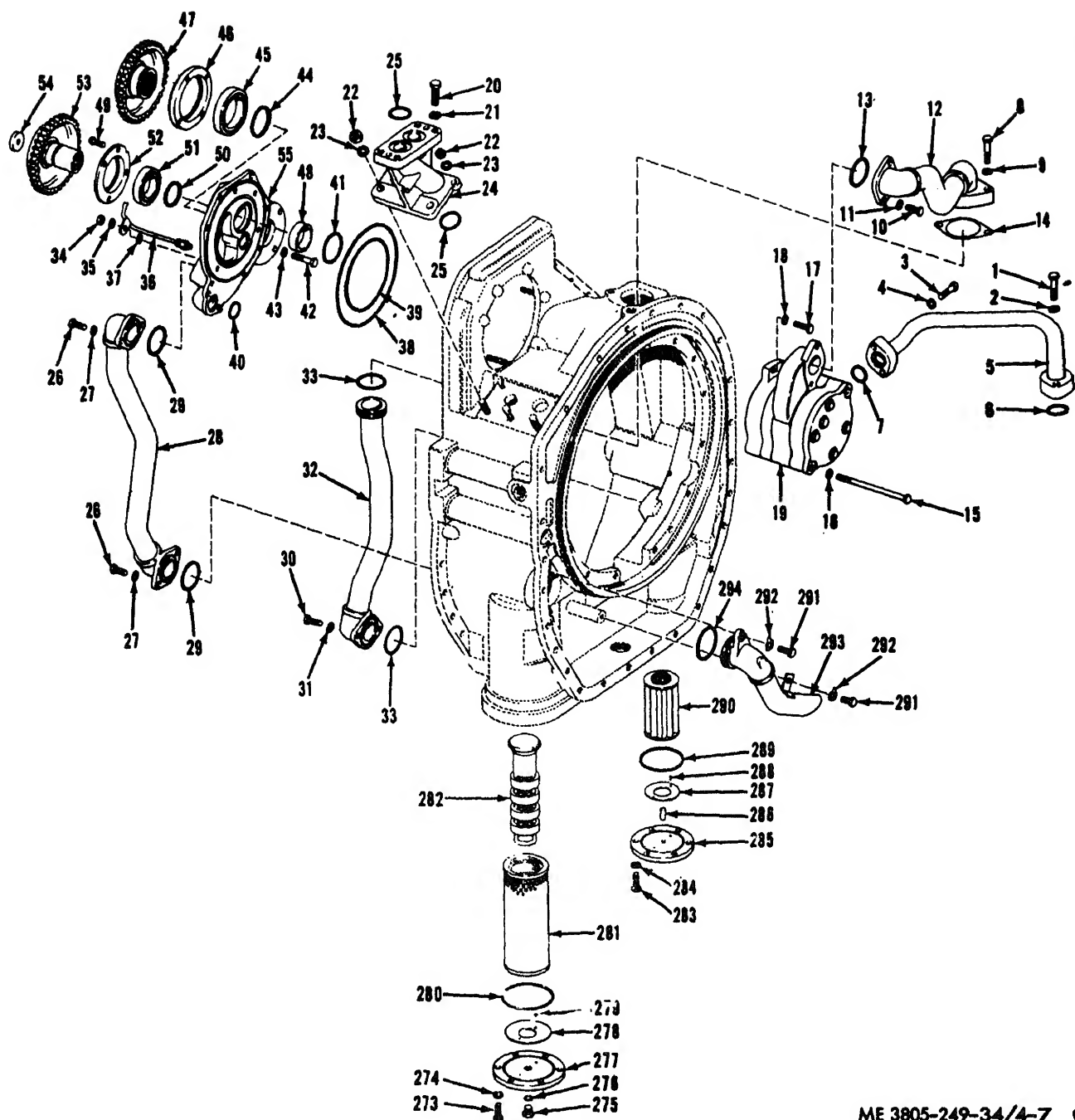
(2) If necessary, adjust the three spools to place the end of the first land flush with the machined surface of the selector valve body.

#### 4-5. Range Transmission

*a. Removal.* Refer to paragraph 2-8 or 2-9. If the tandem drives are removed with the transmission (para 2-8), remove the bolts and lockwashers which secure the transmission housing to the transfer gear housing. Move the transmission to a clean work area.

*b. Disassembly.* (fig. 4-7.)

(1) Steam-clean the exterior of the transmission housing to remove all dirt and grease. Ensure that all tools and the work area are clean.



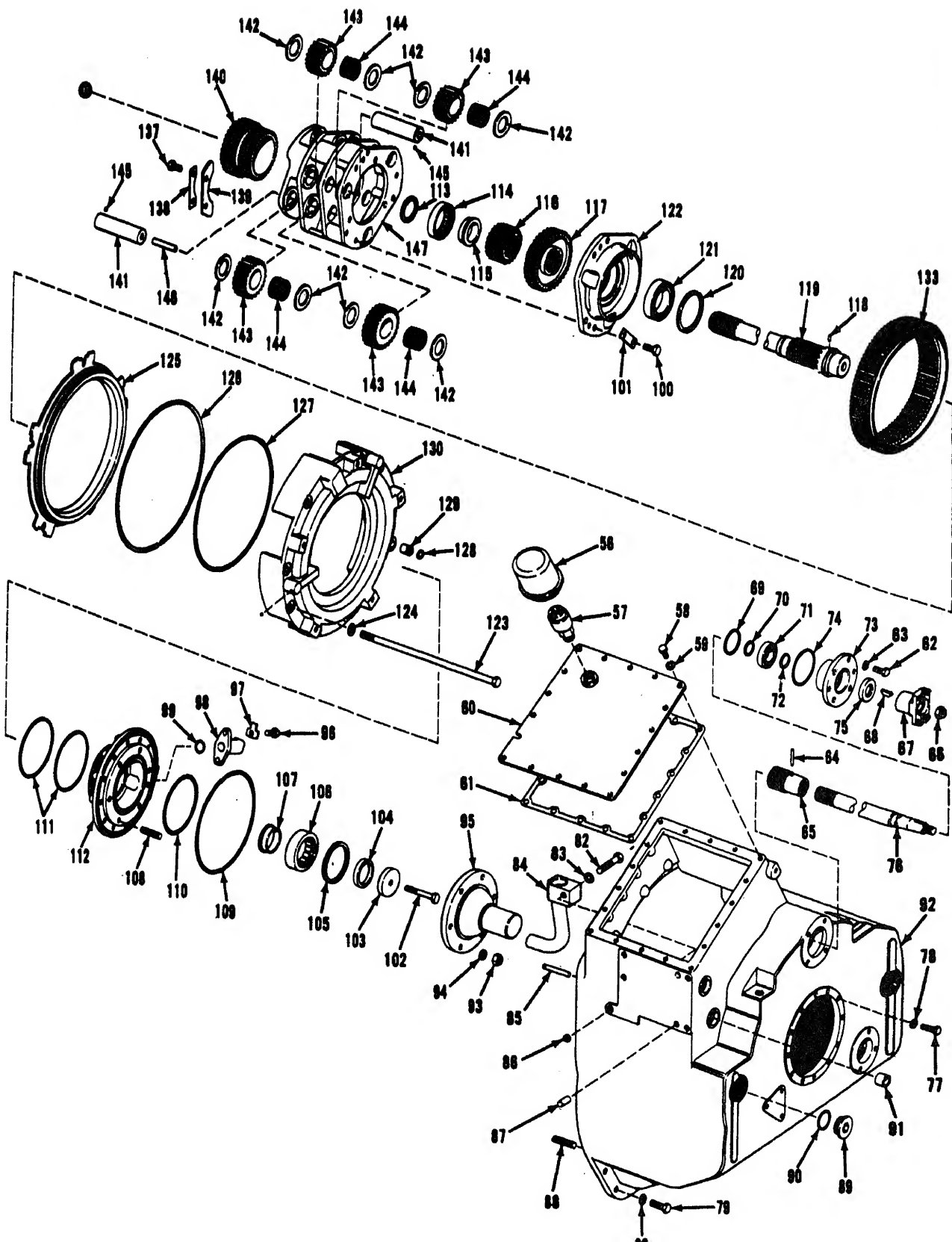
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Figure 4-7. Transmission, exploded view (Sheet 1 of 4).

**KEY to fig 4-7 Sheet 1 of 4:**

1. Bolt
2. Lockwasher
3. Bolt
4. Lockwasher
5. Tube
6. Seal
7. Seal
8. Bolt
9. Lockwasher
10. Bolt
11. Lockwasher
12. Tube
13. Seal
14. Gasket
15. Bolt
16. Lockwasher
17. Bolt
18. Lockwasher
19. Pump assembly
20. Bolt
21. Lockwasher
22. Nut
23. Lockwasher
24. Adapter
25. Seal
26. Bolt
27. Lockwasher
28. Tube
29. Seal
30. Bolt
31. Lockwasher
32. Tube
33. Seal

39. Seal
40. Seal
41. Seal
42. Bolt
43. Washer
44. Seal
45. Bearing
46. Plate
47. Gear
48. Bearing
49. Bolt
50. Seal
51. Bearing
52. Container
53. Gear
54. Cap
55. Manifold
273. Bolt
274. Washer
275. Plug
276. Gasket
277. Cover
278. Plate
279. Screw
280. Seal
281. Screen
282. Tube
283. Bolt
284. Washer
285. Cover
286. Dowel
287. Plate
288. Screw
289. Seal
290. Screen



**KEY to fig 4-7 Sheet 2 of 4:**

56. Cap	99. Seal
57. Breather	100. Bolt
58. Bolt	101. Lock
59. Lockwasher	102. Bolt
60. Cover	103. Retainer
61. Gasket	104. Spacer
62. Bolt	105. Retaining ring
63. Lockwasher	106. Bearing
64. Pin	107. Race
65. Coupling	108. Stud
66. Nut	109. Seal
67. Yoke	110. Seal
68. Key	111. Seal
69. Seal	112. Cage
70. Snap ring	113. Retaining ring
71. Bearing	114. Bearing
72. Ring	115. Race
73. Cage	116. Gear
74. Preformed packing	117. Gear
75. Oil seal	118. Pin
76. Shaft	119. Shaft
77. Bolt	120. Retaining ring
78. Lockwasher	121. Bearing
79. Bolt	122. Cage
80. Lockwasher	123. Bolt
82. Bolt	124. Washer
83. Lockwasher	125. Piston
84. Elbow	126. Oil seal
85. Stud	127. Oil seal
86. Plug	128. Seal
87. Dowel	129. Spacer
88. Stud	130. No. 1 clutch housing
89. Plug	137. Bolt
90. Seal	138. Lock
91. Bushing	139. Plate
92. Housing	140. Gear
93. Nut	141. Shaft
	142. Washer

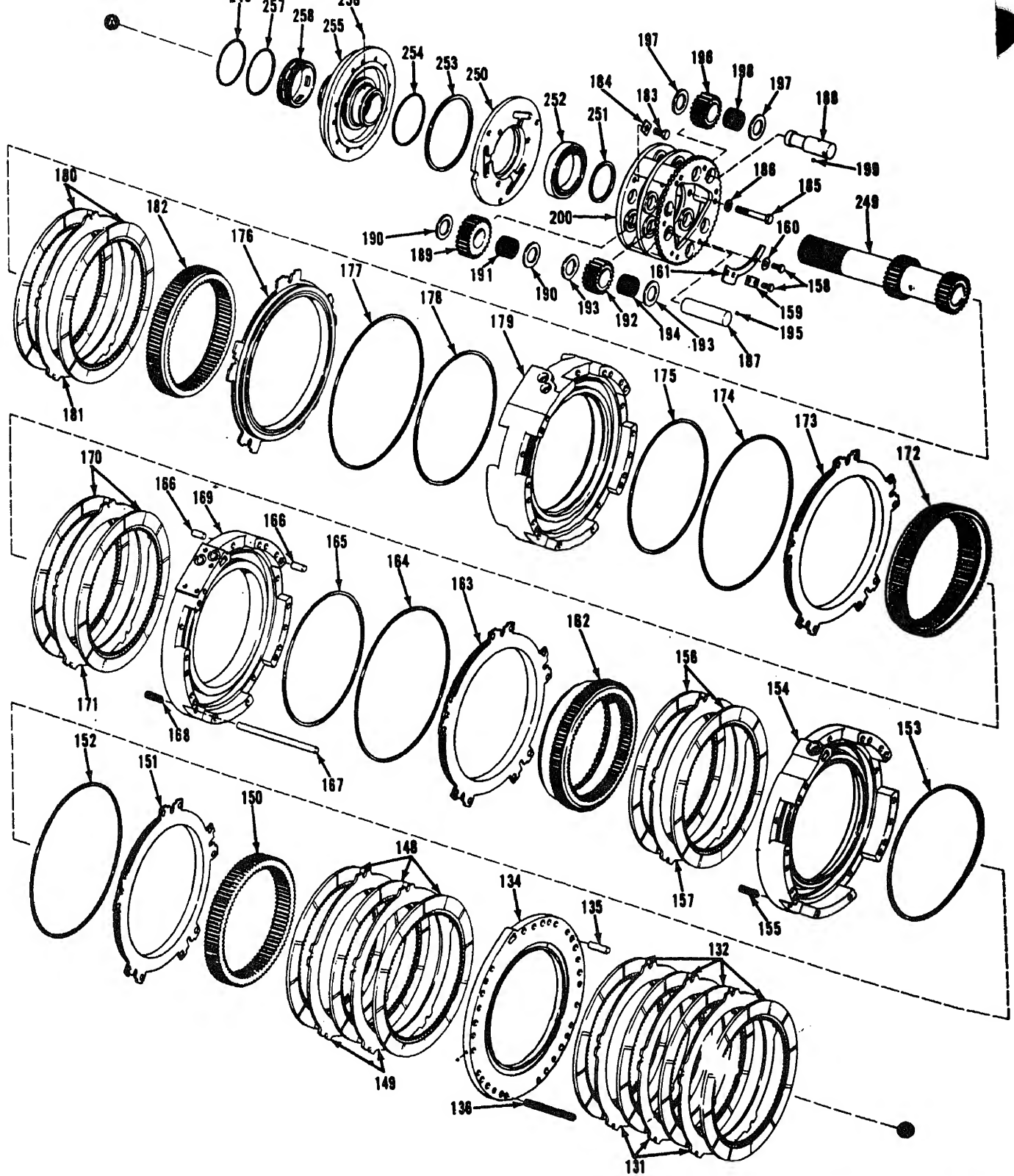
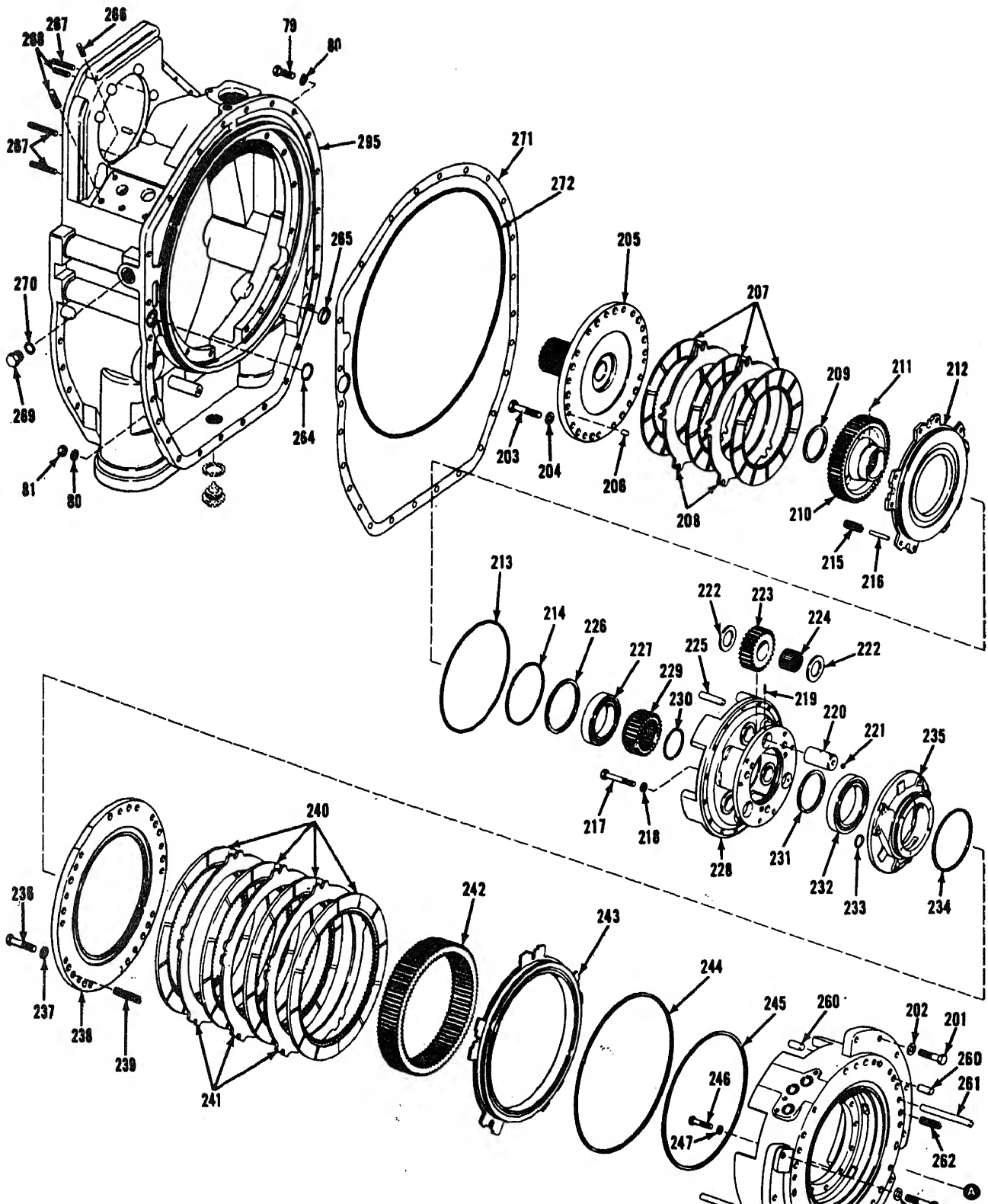


Figure 4-7. Transmission, exploded view (Sheet 3 of 4).

**KEY to fig 4-7 Sheet 3 of 4:**

- |                           |                                     |
|---------------------------|-------------------------------------|
| 131. Clutch plate         | 177. Ring                           |
| 132. Clutch disc          | 178. Ring                           |
| 133. Ring gear            | 179. No. 4 and No. 5 clutch housing |
| 134. Plate                | 180. Clutch disc                    |
| 135. Dowel                | 181. Clutch plate                   |
| 136. Stud                 | 182. Ring gear                      |
| 148. Clutch discs         | 183. Bolt                           |
| 149. Clutch plates        | 184. Lock                           |
| 150. Ring gear            | 185. Bolt                           |
| 151. Piston               | 186. Washer                         |
| 152. Oil seal             | 187. Shaft                          |
| 153. Oil seal             | 188. Shaft                          |
| 154. No. 2 clutch housing | 189. Gear                           |
| 155. Spring               | 190. Washer                         |
| 156. Clutch disc          | 191. Bearing                        |
| 157. Clutch plate         | 192. Gear                           |
| 158. Bolt                 | 193. Washer                         |
| 159. Lock                 | 194. Bearing                        |
| 160. Lock                 | 195. Ball                           |
| 161. Plate                | 196. Gear                           |
| 162. Ring gear            | 197. Washer                         |
| 163. Piston               | 198. Bearing                        |
| 164. Ring                 | 199. Ball                           |
| 165. Ring                 | 200. No. 4 and 5 carrier            |
| 166. Dowel                | 248. Retaining ring                 |
| 167. Dowel                | 249. Shaft                          |
| 168. Spring               | 250. Cage                           |
| 169. No. 3 clutch housing | 251. Retaining ring                 |
| 170. Clutch disc          | 252. Bearing                        |
| 171. Clutch disc          | 253. Seal                           |
|                           | 254. Seal                           |





(2) Remove the tubes (5 and 12) and remove the transmission oil pump (19).

(3) Remove the oil filter and the adapter (24).

(4) Remove the tubes (28 and 32).

(5) Remove seven nuts (34) and washers (35). Remove the tube (36) and the manifold assembly. Disassemble the manifold as follows:

(a) Remove the bolts (42) and lockwashers (43). Pull the bearings (45) from the gear (47) and remove the plate (46).

(b) Rotate the gear (53) until the bolts (49) are visible through openings in the gear. Remove the bolts and remove the gear assembly from the manifold (55). Pull the bearing (51) from the gear (53) and remove the plate (52).

(6) Remove the cap (56), breather (57) and cover (60). Remove the control valve (para 4-4).

(7) Remove the bolts (62) and lockwashers (63) and remove the power control shaft (76). Disassemble as follows:

(a) Drive out the pin (64) and remove the coupling (65).

(b) Place the shaft in a vise and loosen the retaining nut (66). Pull the yoke (67) from the shaft. Remove the nut (66), yoke (67) and key (68).

KEY to fig 4-7 Sheet 4 of 4:	231. Retaining ring
81. Nut	232. Bearing
201. Bolt	233. Seal
202. Washer	234. Seal
203. Bolt	235. Cage
204. Washer	236. Bolt
205. Flange	237. Washer
206. Dowel	238. Plate
207. Clutch disc	239. Spring
208. Clutch plate	240. Clutch disc
209. Retaining ring	241. Clutch plate
210. Gear	242. Gear
211. Pin	243. Piston
212. Piston	244. Oil seal
213. Ring	245. Oil seal
214. Ring	246. Bolt
215. Spring	247. Washer
216. Dowel	259. Dowel
217. Bolt	260. Dowel
218. Washer	261. Dowel
219. Pin	262. Spring
220. Shaft	263. No. 6 and No. 7 clutch housing
221. Ball	264. Seal
222. Washer	265. Seal
223. Gear	266. Stud
224. Bearing	

(c) Remove the seal (69) and snap ring (70). Pull the bearing (71) from the shaft.

(d) Remove the cage (73), preformed packing (74), ring (72) and oil seal (75).

(8) Remove the bolts (77) and lockwashers (78).

(9) Place the transmission so that the transfer gear housing mating side is down. Remove the bolts (79), lockwashers (80) and nuts (81) which secure the two halves of the transmission housing together. Install two 3 / 8-inch eyebolts and lift off the top half of the transmission housing (92).

(10) Remove remaining parts (items 82 through 91) from the housing (92).

(11) Remove the nuts (93) and lockwashers (94) and remove the trunnion (95) from the cage (112).

(12) Remove the bolts (96), locks (97), elbow (98) and seals (99).

(13) Remove the bolts (100) and locks (101). Install two 3 / 8-inch eyebolts into the cage (112) and remove the cage and input shaft assembly (items 102 through 122). Disassemble as follows:

(a) Remove the bolt (102), retainer (103) and spacer (104).

(b) Remove the retaining ring (105) and remove the cage (112) from the shaft.

(c) Remove the bearing (106), race (107), studs (108) and seals (109, 110 and 111) from the cage (112).

(d) Remove the retaining ring (113). Remove the bearing (114), race (115), No. 2 sun gear (116) and No. 1 sun gear (117).

(e) Drive out the pin (118) and remove the cage assembly from the shaft (119). Remove the retaining ring (120) and remove the bearing (121) from the cage (122).

**Caution:** When removing the No. 1 clutch housing (130), hold the piston (125) securely inside the clutch housing. Use two clamps to secure the piston.

(14) Remove the bolts (123) and washers (124). Mark the No. 1 clutch housing (130) for position. Install two 1/2 in.—13NC eyebolts and lift off the No. 1 clutch housing. Remove the piston (125) from the housing. Remove the oil seal (126) from the piston and oil seal (127) from the housing. Remove the seals (128) and spacers (129).

(15) Remove the clutch plates (131) and discs (132). Lift out the ring gear (133), and spacer plate (134). Remove the dowels (135) and studs (136) from the spacer plate.

plates (139) which secure the sun gear (140) to the carrier. Remove the sun gear.

(c) Place the carrier on its side. Pull out the shafts (141) and remove the washers (142), gears (143) and bearings (144).

*Note.* Be careful not to lose the balls (145).

(d) Remove the pins (146).

(17) Remove the No. 2 clutch discs (148) and plates (149). Lift out the ring gear (150).

(18) Install two  $\frac{1}{2}$  in.—18NC eyebolts and remove the No. 2 clutch housing (154). Remove the piston (151) from the housing. Remove the oil seal (152) from the piston and oil seal (153) from the housing. Remove the springs (155) from between the No. 2 and No. 3 clutch housings.

(19) Remove the No. 3 clutch discs (156) and plate (157). Remove the bolts (158), locks (159 and 160) and plates (161) which secure the No. 3 ring gear (162) to the No. 4 and No. 5 carrier. Remove the ring gear.

(20) Install two  $\frac{1}{2}$  in.—13NC eyebolts and remove the No. 3 clutch housing (169). Remove the piston (163) and rings (164 and 165). Remove the dowels (166 and 167) and springs (168).

(21) Remove the No. 4 clutch discs (170), plate (171) and ring gear (172).

(22) Install two  $\frac{1}{2}$  in.—13NC eyebolts and lift off the No. 4 and No. 5 clutch housing (179). Secure the No. 5 piston with two clamps when removing the housing. Remove the No. 4 piston (173) and rings (174 and 175). Remove the No. 5 piston (176) and rings (177 and 178).

(23) Remove the No. 5 clutch discs (180), plate (181) and ring gear (182).

(24) Remove the bolts (183), locks (184), bolts (185) and washers (186). Install two  $\frac{3}{8}$  in.—16NC eyebolts and remove the No. 4 and No. 5 carrier (items 187 through 200). Disassemble as follows:

(a) Pull the shafts (187 and 188) part way out of the carrier. Remove the No. 5 planet gears (189), washers (190) and bearings (191).

(b) Remove the shaft (187) and remove the gear (192), washers (193) and bearing (194). Retain the ball (195).

(c) Remove the shaft (188) and remove the gear (196), washers (197) and bearing (198). Retain the ball (199).

(25) Remove the bolts (201) and washers (202) which secure the No. 6 and No. 7 clutch housing (263), to the transmission housing. Install

(b) Remove the No. 7 clutch discs (207) and plates (208).

(c) Remove the retaining ring (209) and lift off the No. 7 clutch gear (210). Remove the pin (211).

(d) Remove the No. 7 piston (212), rings (213 and 214), spring (215) and dowels (216).

(e) Remove the bolts (217) and washers (218) and remove the No. 7 clutch housing and No. 6 carrier (228). Drive the roll pins (219) to the center of the shafts (220) using a punch and hammer. Remove the shafts from the carrier and drive the roll pins from the shafts. Retain the balls (221). Remove the washers (222), gears (223) and bearings (224). Remove the studs (225).

(f) Remove the retaining ring (226) and drive out the bearing (227) using a punch and hammer.

(g) Remove the No. 6 sun gear (229). Remove the retaining ring (230) which secures the cage (235) in position. Install two  $\frac{1}{2}$  in.—13NC eyebolts and remove the cage. Remove the retaining ring (231) and drive out the bearing (232) using a punch and hammer. Remove the seals (233 and 234).

(h) Remove the bolts (236) and washers (237) and lift off the plate (238). Remove the springs (239).

(i) Remove the No. 6 clutch discs (240), plates (241) and ring gear (242).

(j) Remove the No. 6 piston (243) and oil seals (244 and 245).

(k) Remove the bolts (246) and washers (247). Remove the retaining ring (248). Using a punch and hammer, drive the shaft (249) from the housing.

(l) Install three forcing screws and remove the cage (250). Remove the retaining ring (251) and drive out the bearing (252). Remove the seals (253 and 254).

(m) Remove the manifold (255) from the housing (263). Remove the pin (256). Remove the ring (257) and drive out the bearing (258).

(n) Remove the dowels (259, 260 and 261) and springs (262) from the housing (263).

(26) Remove remaining hardware (items 264 through 272) from the transmission housing (295).

(27) Remove the screen (281), tube (282), screen (290) and tube (293) from the housing.

*c. Cleaning.* Clean all parts except bearings with solvent, and dry with compressed air or clean, lint-free cloths. Clean bearings as instructed in

(2) Inspect gears for chipped, cracked, broken or excessively worn teeth. Check the splines and all machined surfaces for nicks, scratches, scoring, pitting and other surface damage. Remove burrs and minor surface blemishes with a soft hone. Inspect the bores for worn or out-of-round condition. Replace gears if worn or badly damaged.

(3) Inspect cages for cracks, breaks, scoring, scratches and other damage. Check cage pockets for damage and wear. Replace cage if badly damaged or worn.

(4) Inspect springs for cracks and other damage. Replace if damaged or weak.

(5) Inspect retainers for cracks, breaks and deformation. Replace defective retainers.

(6) Inspect pistons for cracks, breaks, scratches, scoring and other damage. Examine the sides of the seal ring grooves. The sides of the grooves must be smooth and square with the rotating axis. Examine the piston face for wear. Remove burrs and scoring with crocus cloth.

(7) Inspect the clutch plates for burrs, imbedded metal particles, pitted faces, excessive wear, cone distortion and damaged spline teeth. Replace if excessively damaged or worn. Remove minor damage with crocus cloth.

(8) Inspect shafts for chipped, cracked, broken or worn teeth. Examine all machined surfaces for nicks, scratches, scoring, pitting and other damage. Remove burrs and minor surface blemishes with a soft honing stone. Replace badly damaged or worn shafts.

(9) Inspect housings for cracks, breaks and damage to machined surfaces. Remove minor surface blemishes with a soft honing stone or crocus cloth. Replace housing if cracked or excessively damaged.

(10) Inspect all other parts for damage, wear and proper fit. Replace parts as required.

*e. Reassembly. (fig. 4-7.)*

(1) Install the screens (281 and 290), tube (282) and tube (293) into the transmission housing (295).

(2) Install dowels, springs and other hardware removed from the housings (92 and 295).

(3) Assemble the No. 6 and No. 7 clutch components (items 203 through 263) as follows:

(a) Install the bearing (258), ring (257) and pin (256) into the manifold (255). Install the manifold (255) in the No. 6 clutch housing (263).

(b) Install the seals (253 and 254) into the manifold (255). Press the bearing (252) into the

(d) Install new rings (244 and 245) on the No. 6 piston (243). Place the No. 6 clutch housing (263) over the piston. Tap the housing with a soft hammer while gently pushing the piston into the housing. Do not hammer the piston into position.

(e) Install the No. 6 ring gear (242), clutch plates (241) and discs (242). Install the spring (239), plate (238), washers (237) and bolts (236).

(f) Install new seals (233 and 234). Press the bearing (232) into the cage (235) and secure with retaining ring (231). Install the cage on the shaft (249) and secure with the retaining ring (230). Press on the gear (229).

(g) Install the bearing (227) and retaining ring (226).

(h) Install the studs (225), bearings (224), gears (223) and washers (222) into the No. 7 clutch housing and No. 6 carrier (228). Install the balls (221) into the shafts (220) and insert the shafts into the carrier. Drive in new roll pins (219). Place the assembly over the shaft (249) and secure with bolts (217) and washers (218).

(i) Install the rings (213 and 214), springs (215) and dowels (216). Press the No. 7 clutch housing and No. 6 carrier (228) over the piston. Install the gear (210) and pin (211) and secure with the retaining ring (209).

(j) Install the No. 7 clutch discs (207) and plate (208).

(k) Install the dowels (206), output flange (205), washers (204) and bolts (203).

(4) Lower the No. 6 and No. 7 clutch components into the transmission housing (295). Secure with bolts (201) and washers (202).

(5) Assemble the No. 4 and No. 5 carrier (items 187 through 200) as follows:

(a) Install the gear (196), washer (197) and bearing (198) in the carrier (200). Position the ball (199) in the shaft (188) and insert the shaft into the carrier.

(b) Position the gears (189 and 192), washers (190 and 193) and bearings (191 and 194) in the carrier. Place the ball (195) in the shaft (187) and insert the shaft into the carrier.

(6) Install the No. 4 and No. 5 carrier (200) in the transmission and secure with bolts (183 and 185), locks (184) and washers (186).

(7) Install the No. 5 clutch ring gear (182) so that the face having the smaller diameter is up. Install the discs (180) and plate (181).

(8) Install the ring (177 and 178) on the No. 5 piston (176) and the rings (174 and 175) on the

No. 3 piston (163). Install the piston in the No. 3 clutch housing (169). Install the housing in the transmission housing.

(11) Install the ring gear (162) and secure to the No. 4 and No. 5 carrier (200) with bolts (158), locks (159 and 160) and plates (161). Install the No. 3 clutch discs (156) and plate (157).

(12) Install the springs (155). Install the seals (152 and 153) and install the No. 2 piston (151) into the No. 2 clutch housing (154). Install the assembly into the transmission housing.

(13) Install the ring gear (150), clutch discs (148) and plates (149).

(14) Assemble the No. 1, No. 2 and No. 3 carrier (items 137 through 147) as follows:

(a) Install the pin (146). Insert the balls (145) into the shafts (141).

(b) Place the carrier (147) on its side, and position the washers (142), gears (143) and bearings (144) in the carrier. Insert the shafts (141).

(c) Secure the sun gear (140) to the carrier with bolts (137), locks (138) and plates (139).

(15) Install the No. 1, No. 2 and No. 3 carrier (147). Install the dowels (135), studs (136), spacer plate (134), ring gear (133), discs (132) and plate (131).

(16) Install the spacers (129) and seals (126, 127 and 128). Position the piston (125) in the No. 1 clutch housing (130). Install the housing in the transmission housing.

(17) Test the clutches for free piston movement as follows:

(a) Force compressed air into each clutch housing. Pistons should move approximately  $\frac{1}{8}$  inch to  $\frac{1}{4}$  inch.

(b) If the piston does not move, disassemble the clutch housing and locate the cause of binding.

(18) Assemble the cage and input shaft (items 102 through 122) as follows:

(a) Press the bearing (121) into the cage (122) and secure with the retaining ring (120). Place the cage assembly on the shaft (119) and drive in a new pin (118).

(b) Install the bearing (114), race (115) and gears (116 and 117). Secure with the retaining ring (113).

(c) Install the bearing (106), race (107), studs (108), and seals (109, 110 and 111) into the cage (112).

(d) Insert the cage (112) onto the shaft (119) and secure with the retaining ring (105).

(e) Install the spacer (104), retainer (103) and bolt (102).

(19) Install the cage and output shaft

(20) Install the seals (99), elbow (98), locks (97) and bolts (96).

(21) Install the trunnion (95) to the cage (112).

(22) Install a new gasket (271) and install the top half of the transmission housing (92). Secure with bolts (79), lockwashers (80) and nuts (81).

(23) Assemble remaining components in the reverse order of disassembly.

*f. Installation.* If the tandem drives and transfer gear housing have been removed from the grader, install the transmission to the transfer gear housing and install in the grader as instructed in paragraph 2-8. If only the transmission has been removed, install in the grader as instructed in paragraph 2-9.

#### 4-6. Oil Cooler

##### *a. Removal and Disassembly. (fig. 4-8.)*

(1) Drain the coolant from the cooling system as instructed in TM 5-3805-249-12.

(2) Remove the drain plug from the bottom of the oil cooler and drain the oil from the cooler.

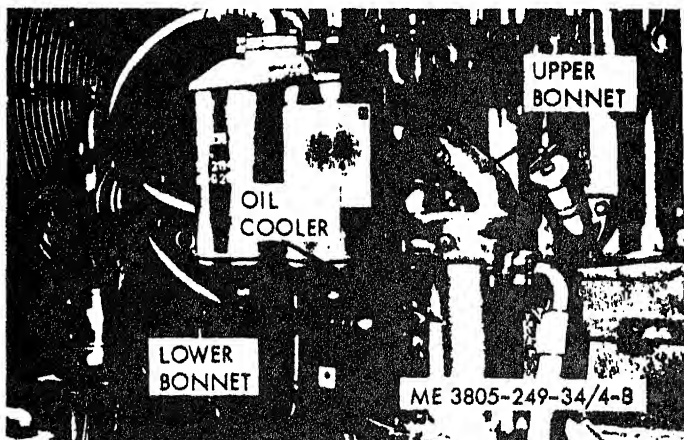


Figure 4-8. Transmission oil cooler.

(3) Remove the bolts and lockwashers and remove the cooler from the upper bonnet. Discard the gasket.

(4) Remove the bolts and lockwashers and separate the lower bonnet from the core. Discard the gasket.

(5) Remove the tube bundle from the core shell.

*b. Cleaning.* Clean all components with solvent and dry with compressed air. Use a rod to clean the water passages in the tube bundle.

##### *c. Inspection and Repair.*

(1) Inspect the core and bonnets for cracks and other damage. Replace as necessary.

(2) Ensure that no tubes are blocked in the tube bundle. If restrictions cannot be removed, replace the tube bundle.

**d. Reassembly and Installation.**

(1) Assemble and install the oil cooler in the reverse order of removal and disassembly. Install new gaskets.

(2) Service the cooling system as instructed in TM 5-3805-249-12.

(3) Check the transmission oil level and add as required. Refer to TM 5-3805-249-12.

(4) Start the engine and check for oil and water leaks.

## **Section II. TRANSFER GEARS, BEVEL GEAR AND PARKING BRAKE**

### **4-7. General**

The transfer gear case houses the flywheel clutch, transfer gears, bevel pinion, bevel gear and parking brake components. The transfer gears transmit power from the transmission to the bevel pinion and bevel gear. The bevel gear engages the final drive gear which drives the axles. The housing serves as a mounting for the transmission and is bolted to the engine at the flywheel.

### **4-8. Transfer Gears, Bevel Gear and Parking Brake**

#### **a. Transfer Gear Housing Removal.**

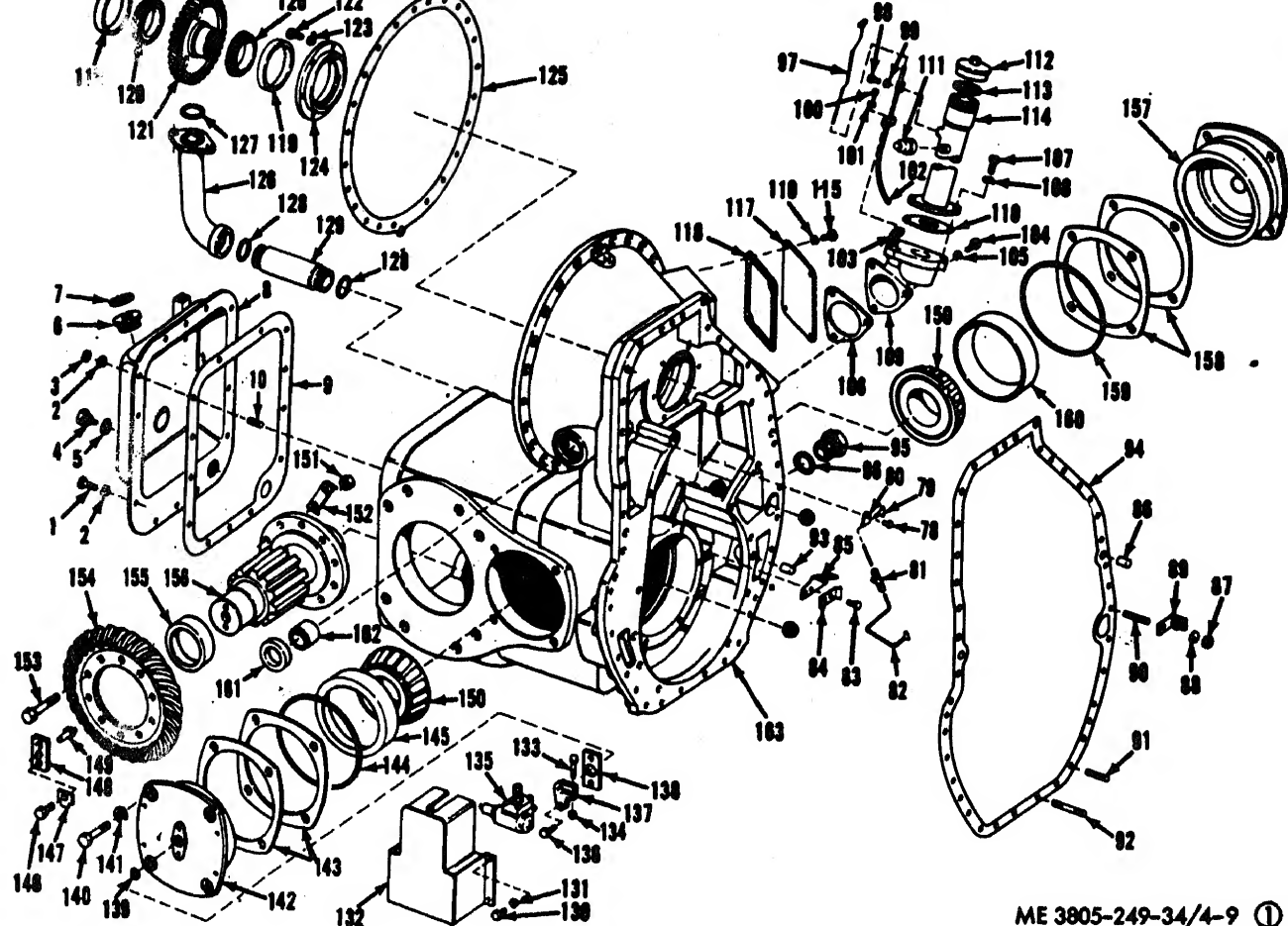
(1) Remove the transmission and tandem drives from the grader as a unit. Refer to paragraph 2-8.

(2) Install three  $\frac{3}{4}$  in. -10NC forged eyebolts and attach a suitable hoist to the transmission. Remove the bolts and nuts which secure the transmission to the transfer gear housing and remove the transmission.

(3) Support the transfer gear housing. Remove the tandem drive housings (para 4-13) and axle and axle housings (para 4-12). Move the transfer gear housing to a clean work area.

#### **b. Disassembly. (fig. 4-9.)**

*Note.* The rear cover and hardware (items 1 through 10) are removed when the final drive gears are separated from the tandem drive housing.

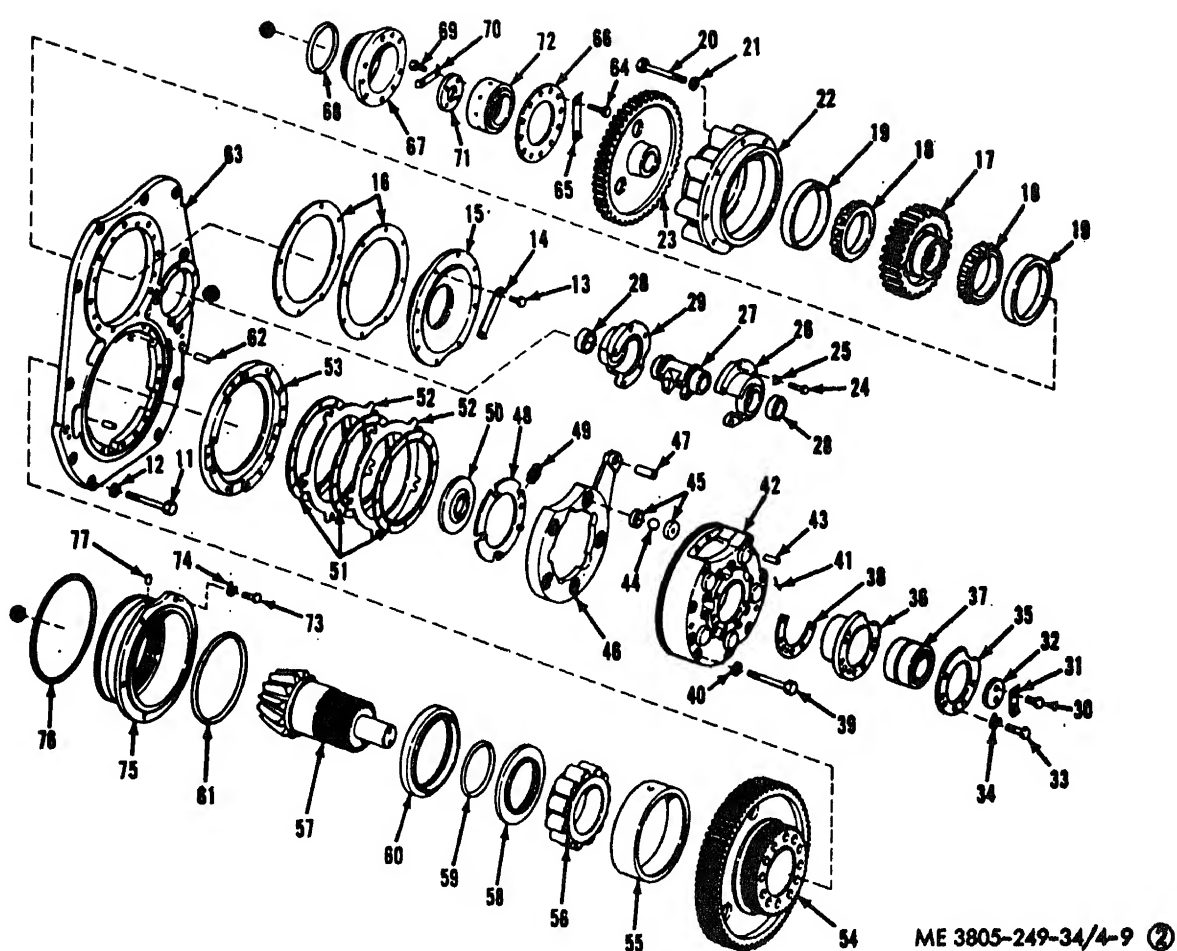


ME 3805-249-34/4-9 ①

- |                |                 |                 |                 |
|----------------|-----------------|-----------------|-----------------|
| 1. Bolt        | 92. Stud        | 116. Lockwasher | 140. Bolt       |
| 2. Lockwasher  | 93. Dowel       | 117. Cover      | 141. Lockwasher |
| 3. Nut         | 94. Gasket      | 118. Gasket     | 142. Cage       |
| 4. Plug        | 95. Plug        | 119. Cup        | 143. Shim       |
| 5. Washer      | 96. Gasket      | 120. Cone       | 144. Seal       |
| 6. Cap         | 97. Gage        | 121. Gear       | 145. Cup        |
| 7. Gasket      | 98. Bolt        | 122. Bolt       | 146. Bolt       |
| 8. Cover       | 99. Lockwasher  | 123. Lock       | 147. Lock       |
| 9. Gasket      | 100. Bolt       | 124. Cage       | 148. Retainer   |
| 10. Stud       | 101. Lockwasher | 125. Gasket     | 149. Adapter    |
| 78. Bolt       | 102. Tube       | 126. Tube       | 150. Cone       |
| 79. Tube       | 103. Gasket     | 127. Seal       | 151. Nut        |
| 80. Clip       | 104. Bolt       | 128. Seal       | 152. Lock       |
| 81. Fitting    | 105. Lockwasher | 129. Tube       | 153. Bolt       |
| 82. Tube       | 106. Gasket     | 130. Bolt       | 154. Gear       |
| 83. Bolt       | 107. Bolt       | 131. Lockwasher | 155. Bushing    |
| 84. Lock       | 108. Lockwasher | 132. Guard      | 156. Shaft      |
| 85. Plate      | 109. Flange     | 133. Bolt       | 157. Cage       |
| 86. Dowel      | 110. Gasket     | 134. Nut        | 158. Shim       |
| 87. Nut        | 111. Breather   | 135. Drive      | 159. Seal       |
| 88. Lockwasher | 112. Cap        | 136. Bolt       | 160. Cup        |
| 89. Bracket    | 113. Gasket     | 137. Clamp      | 161. Seal       |
| 90. Stud       | 114. Tube       | 138. Flange     | 162. Bushing    |
| 91. Stud       | 115. Bolt       | 139. Seal       | 163. Housing    |

Figure 4-9. Transfer gear, bevel gear and parking brake, exploded view (sheet 1 of 2).





- 11. Bolt
- 12. Washer
- 13. Bolt
- 14. Lock
- 15. Cage
- 16. Shims
- 17. Gear
- 18. Cone
- 19. Cup
- 20. Bolt
- 21. Lockwasher
- 22. Cage
- 23. Gear
- 24. Bolt
- 25. Lock
- 26. Cover
- 27. Fork
- 28. Bearing
- 29. Cover
- 30. Bolt
- 31. Lock
- 32. Retainer
- 33. Bolt

- 34. Lock
- 35. Plate
- 36. Cage
- 37. Bearing
- 38. Shim
- 39. Bolt
- 40. Washer
- 41. Rod
- 42. Housing
- 43. Dowel
- 44. Ball
- 45. Insert
- 46. Plate
- 47. Dowel
- 48. Plate
- 49. Spring
- 50. Spacer
- 51. Disc
- 52. Plate
- 53. Ring
- 54. Gear
- 55. Race

- 56. Roller
- 57. Pinion
- 58. Ring
- 59. Ring
- 60. Seal
- 61. Seal
- 62. Dowel
- 63. Cover
- 64. Bolt
- 65. Lock
- 66. Retainer
- 67. Cage
- 68. Seal
- 69. Bolt
- 70. Lock
- 71. Retainer
- 72. Bearing
- 73. Bolt
- 74. Lock
- 75. Cage
- 76. Seal
- 77. Plug

Figure 4-9. Transfer gear, bevel gear and parking brake, exploded view (sheet 2 of 2).



(1) Remove two of the bolts (11) and washers (12) and install guide screws. Loosen the remaining bolts. Install two 3 / 8 inch forcing screws and force the transfer gear assembly one inch away from the transfer gear housing. Install two eyebolts and nuts and attach a hoist. Remove the remaining bolts (11) and washers (12) and remove the pinion and transfer gear assembly. Disassemble as follows:

(a) Remove the bolts (13) and locks (14) and remove the bearing cage (15) and shims (16).

(b) Remove the intermediate transfer gear (17), bearing cones (18) and cups (19). Remove the bearing cones (18) from the transfer gear (17).

(c) Remove the bolts (20) and lockwashers (21). Install three 3 / 8 inch forcing screws in the cage (22). Turn the forcing screws equally and remove the cage. Remove the transfer gear (23).

(d) Remove the bolts (24), locks (25) and control housing (29). Lift off the cover (26) and remove the brake fork (27). Remove the bearings (28) from the cover (26) and housing (29).

(e) Remove the retainer (32) and plate (35). Remove the cage (36) and bearing (37). Retain the shims (38).

(f) Remove the parking brake housing retaining bolts (39) and washers (40). Using a pry bar, expand the springs (48). Remove the spring rods (41) and release the springs. Install two eyebolts and lift off the parking brake housing (42). Remove the dowels (43).

(g) Remove the balls (44) and ball inserts (45) and remove the plate (46) and dowel (47). Remove the spring plate (48) with springs (49). Remove the spacer (50), disc (51) and plates (52).

(h) Remove the ring (53) from the pinion (57). Remove the transfer gear (54). Remove the inner race (55), roller (56) and pinion (57).

(i) Remove the rings (58 and 59) and seals (60 and 61). Remove the dowels (62) from the cover (63).

(2) Remove the retainer (66), cage (67) and seal (68) from the transfer gear housing (163). Remove the retainer (71) and bearing (72).

(3) Remove the cage (75) and seal (76).

(4) Remove the oil tube (items 78 through 83).

(5) Remove remaining hardware. Scrape off the gasket (94). Remove the plug (95) and gasket (96).

(6) Withdraw the level gage (97). Remove the tube (102).

(7) Remove the flange (109), breather (111) and filler tube (114).

(9) Remove the sections of the tube (126 and 129).

(10) Remove the guard (132), drive (135), clamp (137), flange (138) and seal (139).

(11) Remove the bevel gear (154) and bevel gear shaft (156) as follows:

(a) Mark the bearing cages (142 and 157) to ensure proper installation. Block the bevel gear shaft (156), and remove the bearing cage (142). Retain the shims (143). Remove the seal (144) and cup (145).

(b) Move the bevel gear shaft (156) to the right and remove through the rear opening of the transfer gear housing.

(c) Remove the locks (147), retainer (148) and adapter (149).

(d) Using a hydraulic puller, remove the bearing cones (150).

(e) Remove the nuts (151), locks (152), and bolts (153) and remove the bevel gear (154) and bushing (155) from the shaft (156).

(f) Remove the remaining bearing cage (157), shims (158), seal (159) and cup (160).

(12) Remove the seal (161) and bushing (162).

c. *Cleaning.* Clean all components except bearings, in solvent and dry with clean, lint-free cloths or compressed air. Clean bearings as instructed in paragraph 2-6.

#### *d. Inspection and Repair.*

(1) Inspect the bearings for nicks, scratches, scoring and pitting of the bearing surfaces. Replace damaged bearings.

(2) Inspect gears for chipped, cracked, broken or excessively worn teeth. Check the splines and all machined surfaces for nicks, scratches, scoring, pitting and other surface damage. Remove burrs and minor surface blemishes with a soft hone. Inspect the bores for worn or out-of-round condition. Replace gears if worn or excessively damaged.

(3) Inspect cages for cracks, breaks, scoring, scratches and other damage. Check pockets for damage and wear. Replace cage if excessively damaged or worn.

(4) Inspect springs for cracks and other damage. Replace if damaged or weak.

(5) Inspect retainers for cracks, breaks and deformation. Replace defective retainers.

(6) Inspect shafts for chipped, cracked, broken or worn teeth. Inspect all machined surfaces for nicks, scratches, scoring, pitting and other damage. Remove burrs and minor surface blemishes with a

(8) Inspect all other components for damage, wear and proper fit. Replace parts as required.

(9) Replace all worn, damaged or warped plates and discs.

*e. Reassembly.* (fig. 4-9.)

(1) Install the oil tube (item 78 through 83) in position in the transfer gear housing (163).

(2) Install a new seal (76) on the cage (141). Press in a new plug (75). Secure to the transfer gear housing with locks (74) and bolts (73).

(3) Install a new seal (68) on the cage (67). Install the bearings (72) and retainer (66). Position in the transfer gear housing and secure with locks (65) and bolts (64).

(4) Assemble the pinion and transfer gear assembly to the transfer gear cover (63) as follows:

(a) Press in the dowels (62).

(b) Heat the bearing race (55) and roller (56) in oil to not more than 250°F. Install on the pinion (57) and allow to cool. Install the seals (60 and 61) and rings (58 and 59). Install the transfer gear (54) on the pinion and position the assembly on the transfer gear cover. Install the ring (53).

(c) Install the plates (52), discs (51), spacer (50), spring plate (48), springs (49) and plate (46). Install the dowel (47), ball insert (46) and balls (44) in the plate (46).

(d) Install the parking brake housing (42). Expand the springs (49) and secure to the parking brake housing with spring rods (41). Press in the dowels (43) and secure the parking brake housing with washers (40) and bolts (39). Tighten the bolts to a torque of 85 to 105 foot-pounds.

(e) Install the shim (38), cage (36), bearing (37), plate (35) and retainer (32) and secure with bolts and locks.

(f) Heat the bearing cones (18) in oil to not more than 250°F and install on the intermediate transfer gear (17). Allow to cool. Install the cups (19) and install the transfer gear in the cover. Using a dial indicator, measure the bearing end clearance while pushing up on the bearing. End clearance

bearing cage (15) and secure with bolts (13) and locks (14). Tighten the bolts to a torque of 85 to 105 foot-pounds. Install the bearing cage (22) and the transfer gear (23).

(g) Install the bearings (28) in the brake control housing (29) and cover (26). Install the fork (27) and place the cover on the housing. Position on the transfer gear cover (63) and secure with locks (25) and bolts (24).

(5) Position the cover on the transfer gear housing. Secure with bolts (11) and washers (12). Tighten the bolts to a torque of 85 to 105 foot-pounds.

(6) Install the bearing cage (124), cones (120), cups (119) and gear (121). Assemble and install the flywheel clutch (para 4-2). Install a new gasket (125) before assembling to the engine.

(7) Install the bushing (155) to the bevel gear (154). Install on the bevel gear shaft (156) and secure with bolts (153), locks (152) and nuts (151). Press on the bearing cones (150). Install the adapter (149), retainer (148) and locks (147).

(8) Position the bevel gear assembly in the housing. Install the bearing cups (145 and 160), seals (144 and 159) and bearing cages (142 and 157). Check the bevel gear and pinion backlash for 0.012 to 0.016 inch. If necessary, remove the cages (142 and 157) and add shims (143 and 158) to remove all bevel gear shaft end play. Then remove shims to a thickness of 0.008 to 0.012 inch. Reinstall the cages.

(9) Assemble remaining components in the reverse order of disassembly.

(10) Install the tandem drive housings (para 4-13) and axle and axle housings (para 4-12).

(11) Install the rear cover (8).

*f. Installation.*

(1) Install the transmission to the tandem drive housing and secure with bolts and nuts.

(2) Install the transmission and tandem drive housings in the grader. Refer to paragraph 2-8.

### Section III. AXLES AND TANDEM DRIVE

#### 4-9. General

The rear axle is composed of two sections which mount on either side of the transfer gear housing and are driven by the final drive hub. The tandem drive housing is mounted at the end of the axle. Sprockets on the axle drive the tandem drive chains, turning the wheel spindles and rotating the vehicle wheels. A hydraulically-operated expanding

#### 4-10. Wheel Assembly

*a. Removal.*

(1) Remove the tire and rim. Refer to TM5-3805-249-12.

(2) Flatten the lock and remove the nut, lock and washer securing the wheel to the spindle.

(3) Back off the brake adjustment screw a few turns so that the brake shoes will not contact the

*Note.* Before pulling the wheel from the spindle, install a 1 7/8 in. -12NF nut flush with the end of the spindle. This will protect the spindle threads and will prevent the wheel from coming all the way off.

(4) Remove four bolts securing the brake drum to the wheel, and install a hydraulic puller. Pull the wheel from the spindle.

*b. Cleaning.* Clean the tire, rim and wheel with a detergent and scrub brush. Rinse with clean water.

*c. Inspection and Repair.*

(1) Inspect the wheel for cracks, breaks or other damage. Repair by welding if possible.

(2) Inspect the tire for uneven or excessive wear. Inspect the valve core for deterioration. Replace parts as required.

*d. Installation.*

(1) Aline the keyway in the wheel with the key on the spindle.

(2) Press the wheel onto the spindle with a force of  $30 \pm 1.5$  tons (60,000  $\pm$  3,000 pounds).

(3) Install the washer, lock and nut on the spindle. Tighten the nut to a torque of 300 to 350 foot-pounds. Secure the nut with the lock.

(4) Install the tire and rim on the wheel. Adjust the brakes. Refer to TM5-3805-249-12.

## 4-11. Wheel Spindles

### *a. Removal and Disassembly.* (fig. 4-10.)

*Note.* The wheel spindles can be removed while the tandem drive housing is removed from or installed on the grader.

(1) Remove the tire and rim from the wheel. Refer to TM5-3805-249-12.

(2) Remove the drive chains (para 4-14).

(3) Remove the wheel from the spindle (para 4-10).

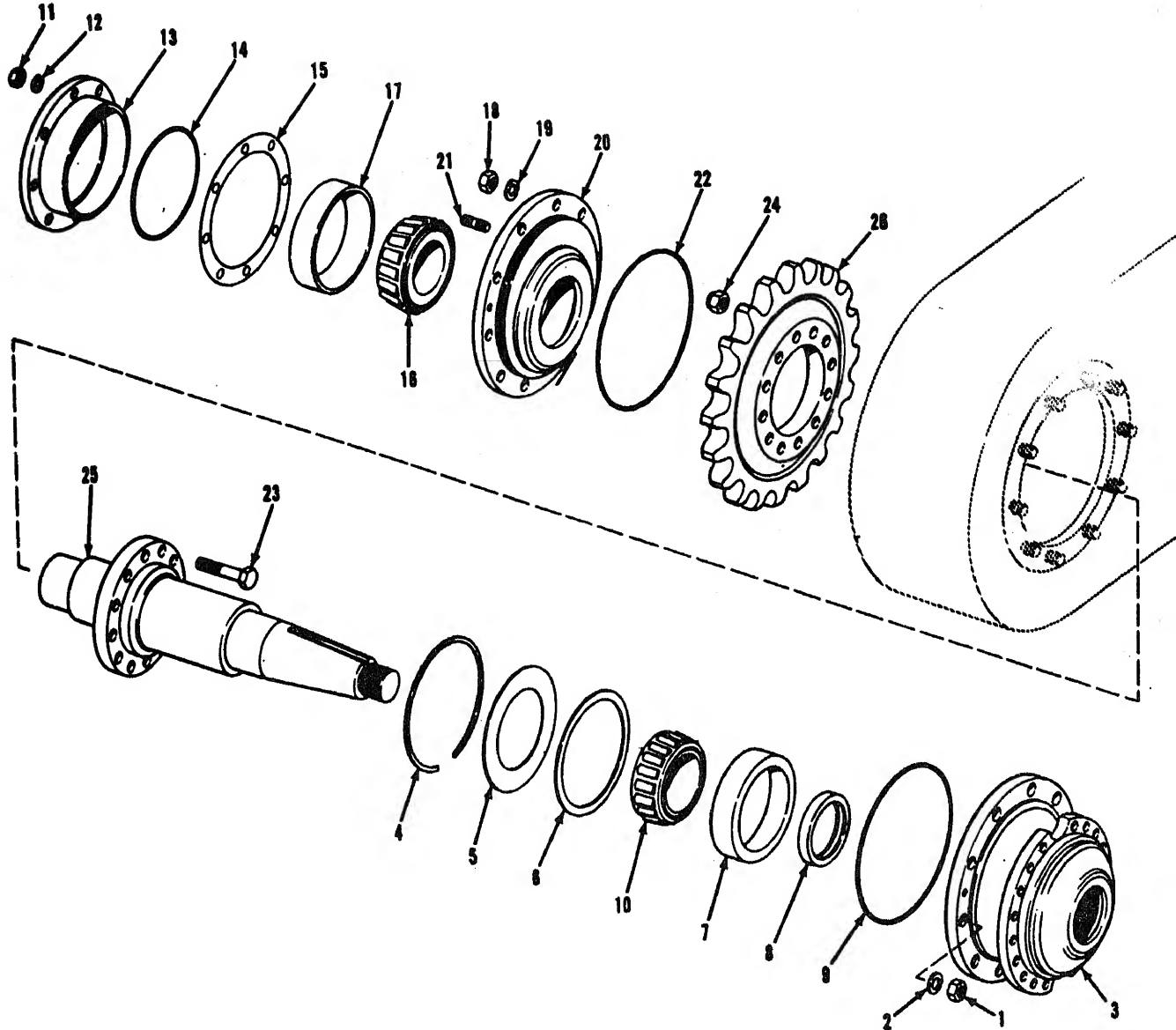
(4) Remove the brake backing plate (para 4-16).

(5) Mark the eccentric cages (3 and 20) and the tandem drive housing so that the cages can be installed in the same position.

(6) Attach a suitable hoist to the outer bearing cage (3). Remove ten nuts (1) and lockwashers (2) which secure the outer bearing cage (3) to the tandem drive housing.

(7) Thread two 5/8 in. —11NC bolts (1 1/2 inches long) into the tapped holes in the outer bearing cage. Force the cage away from the tandem drive housing.

(8) Move the cage out onto the spindle. Pry out the retaining ring (4).



ME 3805-249-34/4-10

1. Nut
2. Lockwasher
3. Cage
4. Retaining ring
5. Retainer
6. Gasket
7. Cup
8. Seal
9. Seal
10. Cone
11. Nut
12. Lockwasher
13. Cage

14. Seal
15. Shim
16. Cone
17. Cup
18. Nut
19. Lockwasher
20. Cage
21. Stud
22. Seal
23. Bolt
24. Nut
25. Spindle
26. Sprocket

Figure 4-10. Wheel spindle, exploded view.

(9) Move the cage away from the spindle and place on a clean work table.

(10) Remove the retainer (5), gasket (6), bearing cup (7) and seals (8 and 9) from the cage.

(11) Using a hydraulic puller, remove the outer bearing cone (10) from the spindle.

(12) Remove the nuts (11) and lockwashers (12) and remove the inner bearing cage (13). Remove the seal (14) and retain the shims (15).

(13) Using a hydraulic puller, press the spindles (25) from the bearing cone (16). Remove the bearing cone and the bearing cup (17).

(14) Remove the nuts (18) and lockwashers (19) and remove the inner eccentric cage (20). Remove the studs (21) and seal (22).

(15) Remove the bolts (23) and nuts (24) and remove the driven sprockets (26) from the spindle (25). Remove the spindle.

(16) To remove the sprockets (26), the tandem drive housing must be removed from the grader. The sprockets can be removed through the opening for the drive sprocket.

**b. Cleaning.** Clean all components except bearings in solvent and dry with clean, lint-free cloths. Clean bearings as instructed in paragraph 2-6.

#### **c. Inspection and Repair.**

(1) Inspect cages, spindles and sprockets for cracks, breaks, scoring, other damage and wear. Repair by welding if possible. Replace parts as necessary.

(2) Inspect the bearing cups and cones for nicks, scratches, burrs, scoring, pitting and wear. Replace damaged bearings.

(3) Inspect all other parts for burrs and surface damage. Smooth surfaces with a soft hone or crocus cloth.

#### **d. Reassembly and Installation.** (fig. 4-10.)

(1) Install the sprocket (14) if removed. Install the spindle (25) and secure with nuts (24) and bolts (23). Tighten the nuts to a torque of 210 to 250 foot-pounds.

(2) Heat the bearing cone (16) in oil. Do not allow oil temperature to exceed 250° F. Press the one onto the spindle and allow to cool.

(3) Install the inner eccentric cage (20) and secure with nuts (16) and lockwashers (17).

Tighten the nuts to a torque of 128 to 152 foot-pounds.

(4) Install the studs (21), seal (22) and bearing cup (17).

(5) Install the inner bearing cage (13) without installing the shims (15). Tighten the nuts (11) evenly to remove all bearing end clearance.

(6) Measure the distance between the inner bearing cage (13) and the inner eccentric cage (20) using a thickness gage.

(7) Remove the cage (13). Install shims (15) to obtain a clearance of 0.005 to 0.015 inch. Install the cage (13), seal (14), lockwashers (12) and nuts (11).

(8) Heat the outer bearing cone (10) in an oil bath. Do not allow oil temperature to exceed 250° F. Press the cone onto the spindle and allow to cool.

(9) Install the seal (8) so that the spring-loaded lip is toward the tandem drive housing. Install the seal (9), bearing cup (7), new gasket (6) and the retainer (5). Install the retaining ring (4).

(10) Secure the outer bearing cage (3) to the tandem drive housing with the bolts (1) and lockwashers (2). Tighten the bolts to a torque of 128 to 152 foot-pounds.

(11) Install the brake backing plate (para 4-16).

(12) Install and adjust the drive chains (para 4-14).

(13) Install the tandem drive housing (para 4-13) if removed from the grader.

(14) Install the wheels (para 4-10).

#### **4-12. Axle and Axle Housing**

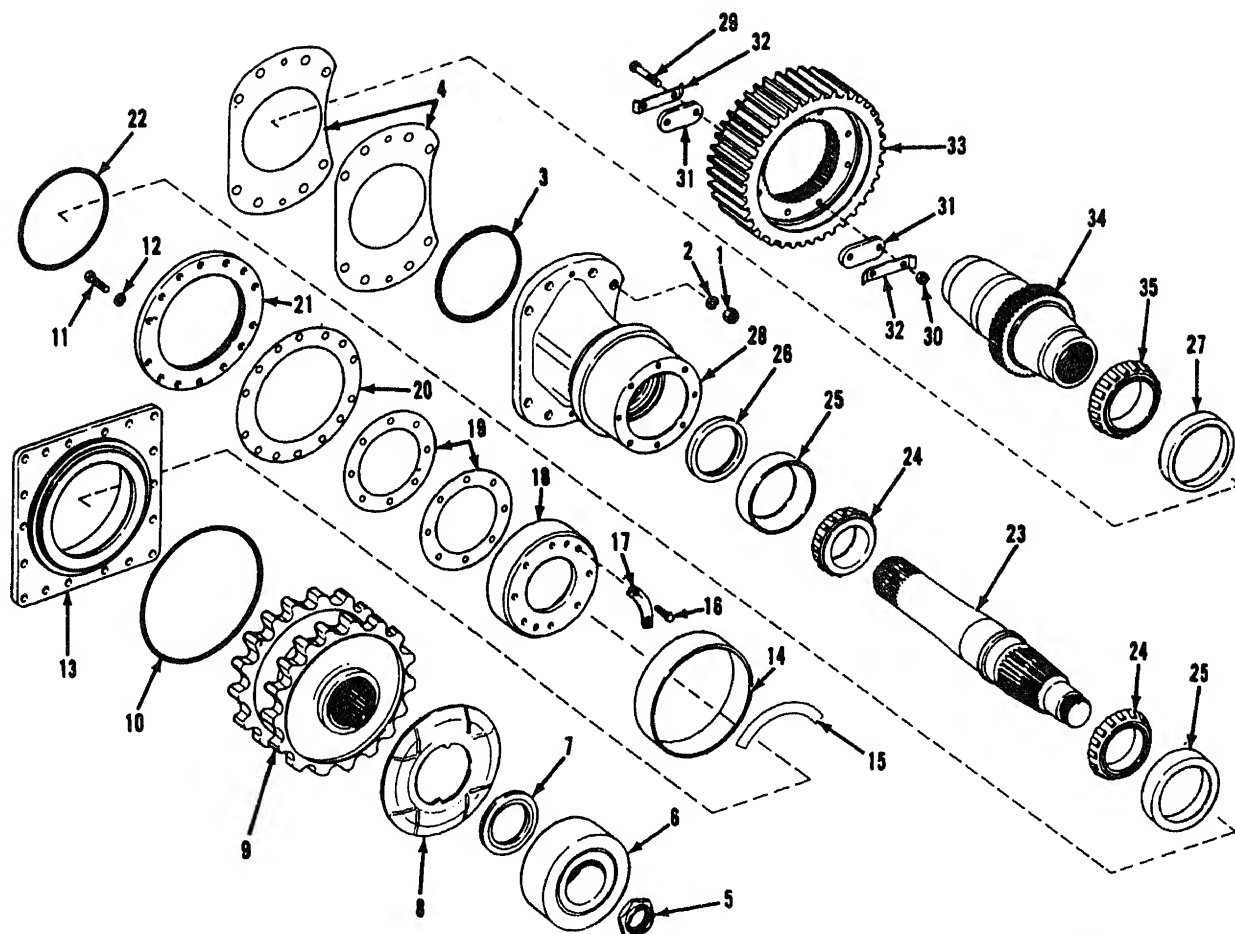
##### **a. Removal and Disassembly.** (fig. 4-11.)

(1) Remove the tandem drive housing (para 4-13).

(2) Remove the bearing caps which secure the axle housings to the frame. Place blocking under the final drive housing.

(3) Raise the frame until the axle bracket clears the axle housing. Block the frame in position.

(4) Support the axle housing (28) and remove the nuts (1) and lockwashers (2) which secure the axle housing to the transfer gear housing.



ME 3805-249-34/4-11

1. Nut
2. Lockwasher
3. Seal
4. Shim
5. Nut
6. Bearing
7. Spacer
8. Oil slinger
9. Sprocket
10. Seal
11. Bolt
12. Lockwasher
13. Bearing cage
14. Bearing
15. Thrust washer
16. Bolt
17. Lock
18. Bearing adjuster

19. Shim
20. Gasket
21. Plate
22. Seal
23. Axle shaft
24. Bearing cone
25. Bearing cup
26. Oil seal
27. Bearing cup
28. Axle housing
29. Bolt
30. Nut
31. Plate
32. Lock
33. Gear
34. Hub
35. Bearing cone

Figure 4-11. Axle assembly, exploded view.

(5) Pull the axle housing away from the

(7) Loosen the bearing retaining nut (5) and

(10) Remove the bolts (11) and lockwashers (12) and remove the bearing cage (13). Remove the bearing (14) and thrust washer (15) from the bearing cage.

(11) Remove the bolts (16) and locks (17). Remove the bearing adjuster (18). Remove the shims (19), gasket (20), plate (21) and seal (22).

(12) Remove the axle shaft (23) and bearing cones (24) from the axle housing.

(13) Remove the bearing cones (24) from the axle shaft using a hydraulic puller.

(14) Remove the bearing cups (25).

(15) Remove the oil seal (26) and the final drive hub bearing cup (27) from the axle housing (28).

(16) Drain the oil from the transfer gear housing and remove the rear cover.

(17) Remove the bolts (29), nuts (30), plates (31) and locks (32) which secure the final drive gear (33) to the hub (34). Block the gear in place.

(18) Slide the hub (34) through the opening in the right side of the transfer gear housing. Remove the final drive gear through the rear of the housing.

(19) Remove the bearing cone (35) from the final drive hub using a hydraulic puller.

*b. Cleaning.* Clean all components except bearings in solvent. Dry with compressed air or clean, lint-free cloths. Clean bearings as instructed in paragraph 2-6.

#### *c. Inspection and Repair.*

(1) Inspect the axle housing for cracks, burrs and damage to the machined surfaces. Remove burrs and minor surface irregularities with a soft hone or crocus cloth. Replace if cracked or badly damaged.

(2) Inspect the shaft for nicked or broken teeth and for cracks, burrs, scoring, pitting and wear. Repair by welding and remachining if possible. Remove burrs and other minor surface damage using a soft hone or crocus cloth.

(3) Inspect the bearing cones and cups for nicks, scratches, scoring, pitting and flat spots. Replace the cone and cup as a set if either is damaged.

(4) Inspect thrust washers and oil slingers for damage and wear. Replace if damaged or if wear is excessive.

#### *d. Reassembly and Installation.* (fig. 4-11.)

(1) Heat the bearing cone (35) in oil to no more than 250°F and press onto the hub (34).

(2) Install the final drive gear (33) in the transfer gear housing. Install the hub (34) and secure with bolts (29), locks (32), plates (31) and

(4) Install the oil seal (26) into the housing so that the lip faces the final drive end of the housing.

(5) Heat the bearing cones (24) in oil to no more than 250°F. Install the cones on the axle shaft (23) and allow to cool.

(6) Start the inner bearing cup (25) into its bore in the axle housing.

(7) Install the axle shaft (23) in the housing. Be careful not to damage the oil seal (26).

(8) Install the remaining bearing cup (25).

(9) Install the seal (22), plate (21) and gasket (20). Install the bearing adjuster (18) in an inverted position. Secure with four evenly spaced bolts (16). Tighten the bolts evenly to pull the bearing cups into place.

(10) When the inner bearing cup (25) seats, loosen the bolts (16). Tap the axle to obtain end clearance. Retighten the bolts (16) evenly to remove all axle end clearance.

(11) Measure the distance between the housing and the inverted adjuster.

(12) Remove the adjuster. Add shims (19) to a total thickness of 0.010 inch less than the distance measured above. Install the adjuster in its normal position. Secure with the locks (17) and bolts (16). Tighten the bolts to a torque of 130 to 170 foot-pounds.

(13) Install the thrust washer (15), bearing (14) and bearing cage (13). Secure with the bolts (11) and lockwashers (12).

(14) Install a new seal (10).

(15) Install the sprocket (9), oil slinger (8) and spacer (7). Install the spacer so that the beveled side is out.

(16) Heat the bearing (6) in oil to no more than 250°F and install on the axle shaft. Allow to cool and install the bearing retaining nut (5).

(17) Install the shims (4) and seal (3). Install the axle assembly to the transfer gear housing in the reverse order of removal. Secure with nuts (1) and lockwashers (2).

(18) Install the tandem drive housing (para 4-13).

(19) Service the transfer gear housing and tandem drive housing (TM5-3805-249-12).

### **4-13. Tandem Drive Housing**

#### *a. Removal.*

(1) Drain the lubricant from the tandem drive housing. Refer to TM5-3805-249-12.

(2) Raise the rear of the grader so that the four tandem drive wheels are off the ground. Block in position. Place additional blocking under the rear



(5) Disconnect the hydraulic line to the tandem drive housing. Cap or plug openings.

(6) Attach a suitable hoist to the tandem drive housing.

(7) Remove 20 bolts and lockwashers and remove the bearing cage cover from the outside of the tandem drive housing. Remove the gaskets.

(8) Install two  $\frac{3}{4}$  in. -11NC forcing screws into the tapped holes to force the bearing cage away from the tandem drive housing. Remove the bearing cage.

(9) Remove 18 nuts and lockwashers securing the tandem drive housing to the pivot bearing cage. Move the tandem drive housing away from the grader and lower to the ground.

*b. Disassembly.*

(1) Remove the wheel spindles (para 4-11).

(2) Remove the bolts and lockwashers securing the inspection covers to the housing.

*c. Cleaning.* Clean the exterior of the tandem drive housing with soap and water. Clean the interior of the housing and other components with solvent.

*d. Inspection and Repair.*

*Note.* Refer to paragraph 4-14 for drive chain repair and paragraph 4-11 for wheel spindle repair.

(1). Inspect the tandem drive housing for cracks, chips, scratches and damaged weld. Repair by welding.

(2) Inspect the pivot bearing cage for cracks, chips and other damage. Repair or replace as necessary.

(3) Inspect the inspection covers for damage and distortion. Repair or replace as required. Replace the gaskets.

*e. Reassembly.* Assemble the tandem drive housing in the reverse order of disassembly.

*f. Installation.* Install the tandem drive housing in the reverse order of removal. Tighten the nuts securing the tandem drive housing to the pivot bearing cage to a torque of 128 to 152 foot-pounds.

#### 4-14. Tandem Drive Chains

*a. Removal.*

(1) Drain the lubricant from the tandem drive housing. Refer to TM5-3805-249-12.

(2) Raise the rear end of the grader so that all tandem drive wheels are off the ground. Block the frame and the tandem drive housings.

(3) Remove the tires and rims from the side of

the grader from which the drive chain is to be removed. Refer to TM5-3805-249-12.

(4) Remove the inspection covers from the tandem drive housing.

(5) Rotate the wheels until the drive chain master link is at the inspection opening.

(6) Remove two cotter pins from the master link. Fabricate the tool set (fig. 2-1) and remove the drive chain master link.

(7) Rotate the wheels until the drive chain is freed from the drive sprockets, and remove the chain from the tandem drive housing.

*b. Cleaning.* Clean the drive chain in solvent. Dry with clean, lint-free cloths or with compressed air.

*c. Inspection and Repair.* Inspect the drive chain for broken or damaged links. Replace links as required. Replace the master link if it is damaged.

*d. Installation.*

(1) Attach a rope to one end of the drive chain. Pass the rope over the axle shaft, under the wheel spindle, and back through the inspection opening.

(2) Start the chain onto the drive sprocket and rotate the wheels on the opposite side of the grader to draw the chain around the drive sprocket. Continue rotating the wheels until the chain engages the sprocket on the spindle and the two ends of the chain are at the inspection opening.

(3) Install the master link using the tool set (fig. 2-1) and secure with two new cotter pins.

*e. Adjustment.*

*Note.* Adjust the tension on the drive chains when a new chain is installed or whenever the sag in the chain exceeds four inches.

(1) Rotate the eccentric cages of the wheel spindle bearings to tighten the chain.

(2) Measure the distance from the top of the tandem drive housing to the chain while the chain is tight and again while the chain is loose. The difference between the readings must not exceed four inches.

*Note.* Make the chains tight or loose by moving the grader back and forth.

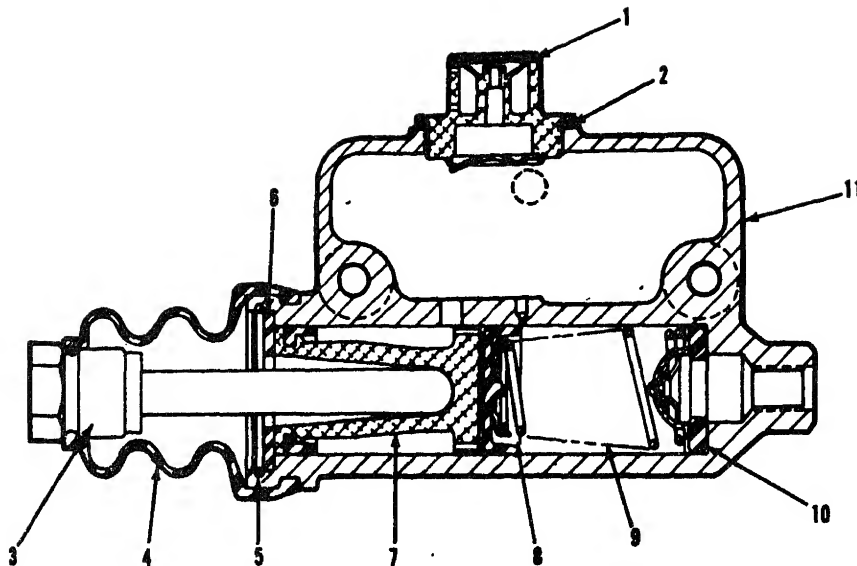
#### 4-15. Brake Master Cylinder

*a. Removal.* Refer to TM5-3805-249-12.

*b. Disassembly.* (fig. 4-12.)

(1) Remove the cap (1) and gasket (2) and drain any hydraulic fluid trapped in the cylinder.





ME 3805-249-34/4-12

1. Cap
2. Gasket
3. Control rod
4. Boot
5. Lockwire
6. Retainer plate

7. Piston
8. Cup
9. Spring
10. Check valve
11. Housing

Figure 4-12. Brake master cylinder, cross section.

(2) Remove the control rod (3) and boot (4). Cut the lockwire (5) and remove the retainer plate (6).

(3) Remove the piston (7), cup (8), spring (9), and check valve (10) from the master cylinder housing (11).

*c. Cleaning.* Clean all components in solvent and dry with compressed air.

*d. Inspection and Repair.*

*Note.* A master cylinder rebuild kit containing a check valve, cup, boot and piston is available. If possible, install a rebuild kit whenever the master cylinder is disassembled rather than repair individual components.

(1) Inspect the housing and other metal components for cracks and other damage. Repair or replace as required.

(2) Inspect the piston for scoring, pitting, scratches, chips and other damage and for excessive or uneven wear. Repair if possible.

(3) Replace deteriorated or damaged boot.

(2) Lubricate the cup (8) with hydraulic brake fluid. Install the cup and piston (7).

(3) Install the retainer plate (6). Hold the components in place against the force of the spring and secure with lockwire (5).

(4) Install the boot (4) on the control rod (3) and install on the master cylinder housing (11).

(5) Install a new gasket (2) and the cap (1).

*f. Installation.* Refer to TM5-3805-249-12.

#### 4-16. Wheel Brakes

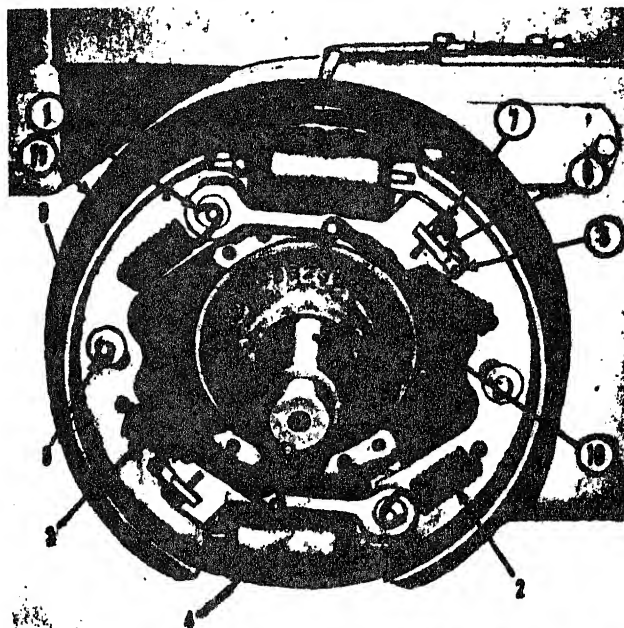
*a. Removal and Disassembly.* (fig. 4-13.)

(1) Remove the tire and rim. Refer to TM5-3805-249-12.

(2) Remove the wheel (para 4-10). Remove the bolts and lockwashers which secure the brake drum to the wheel.

(3) Disconnect the hydraulic brake line at the master cylinder. Cap or plug openings.

(4) Loosen the anchor pin lock nuts on the back of the brake backing plate. Turn the anchor



ME 3805-249-34/4-13

- |                   |                             |
|-------------------|-----------------------------|
| 1. Anchor pin     | 7. Wheel                    |
| 2. Spring         | 8. Retainer                 |
| 3. Spring         | 9. Shoe and lining assembly |
| 4. Wheel cylinder | 10. Bolt and washer         |
| 5. Screw          | 11. Backing plate           |
| 6. Clamp          |                             |

Figure 4-13. Wheel brake.

(5) Remove the brake return springs (2 and 3).

(6) Remove the tube from the wheel cylinders. Cap or plug openings.

(7) Remove two bolts securing each wheel cylinder (4) to the backing plate, and remove the wheel cylinders.

(8) Remove the screw (5), spring clamp (6) and adjusting wheel (7).

(9) Remove the cotter pins and retainers (8) securing the shoe and lining assembly (9) to the backing plate. Remove the shoe and lining assembly.

(10) Remove the bolts and washers (10) which secure the brake backing plate (11) to the wheel spindle outer bearing cage. Remove the backing plate.

**b. Cleaning.** Clean all components with solvent. Dry with compressed air or clean, lint-free cloths.

### c. Inspection and Repair.

(1) Inspect the brake drum bore for nicks, scratches and other damage. Remove slight damage with abrasive cloth.

(2) Inspect the brake lining for oil saturation, damage or wear. Check the brake shoe for cracks and damage. Replace the shoe and lining assembly if damage or wear is evident.

(3) Examine the brake return springs for cracks and weakness. Replace as necessary.

(4) Inspect the adjusting wheels for cracks, broken, worn or missing lugs. Replace the wheel if damaged or worn.

(5) Inspect the anchor pins and backing plate for cracks and other damage. Repair the backing plate by welding if a replacement part is not available. Replace damaged anchor pins.

(6) Examine the tube for kinks, breaks, cracks and damage to the flared ends. Replace the tube if damaged.

**d. Reassembly and Installation.** Assemble and install the wheel brake in the reverse order of removal. Tighten the backing plate mounting bolts (10, fig. 4-12) to a torque of 55 to 65 foot-pounds. Bleed and adjust the brakes as instructed in TM5-3805-249-12.

### 4-17. Wheel Cylinder

#### a. Removal.

(1) Remove the tire and rim. Refer to TM5-3805-249-12.

(2) Remove the wheel (para 4-10).

(3) Disconnect the hydraulic brake line to the wheel cylinder. Cap or plug openings.

(4) Remove the two bolts and lockwashers which secure the wheel cylinder to the brake backing plate.

(5) Remove the brake drum return springs.

(6) Pry the brake shoes outward and remove the wheel cylinder.

**b. Repair.** Replacement parts are not available for the wheel cylinder. If the cylinder is defective, install a new cylinder.

**c. Installation.** Install the wheel cylinder in the reverse order of removal. Bleed the brakes as instructed in TM5-3805-249-12.



# CHAPTER 5

## REPAIR OF POWER CONTROL COMPONENTS

### Section 1. POWER CONTROL UNIT

#### 5-1. General

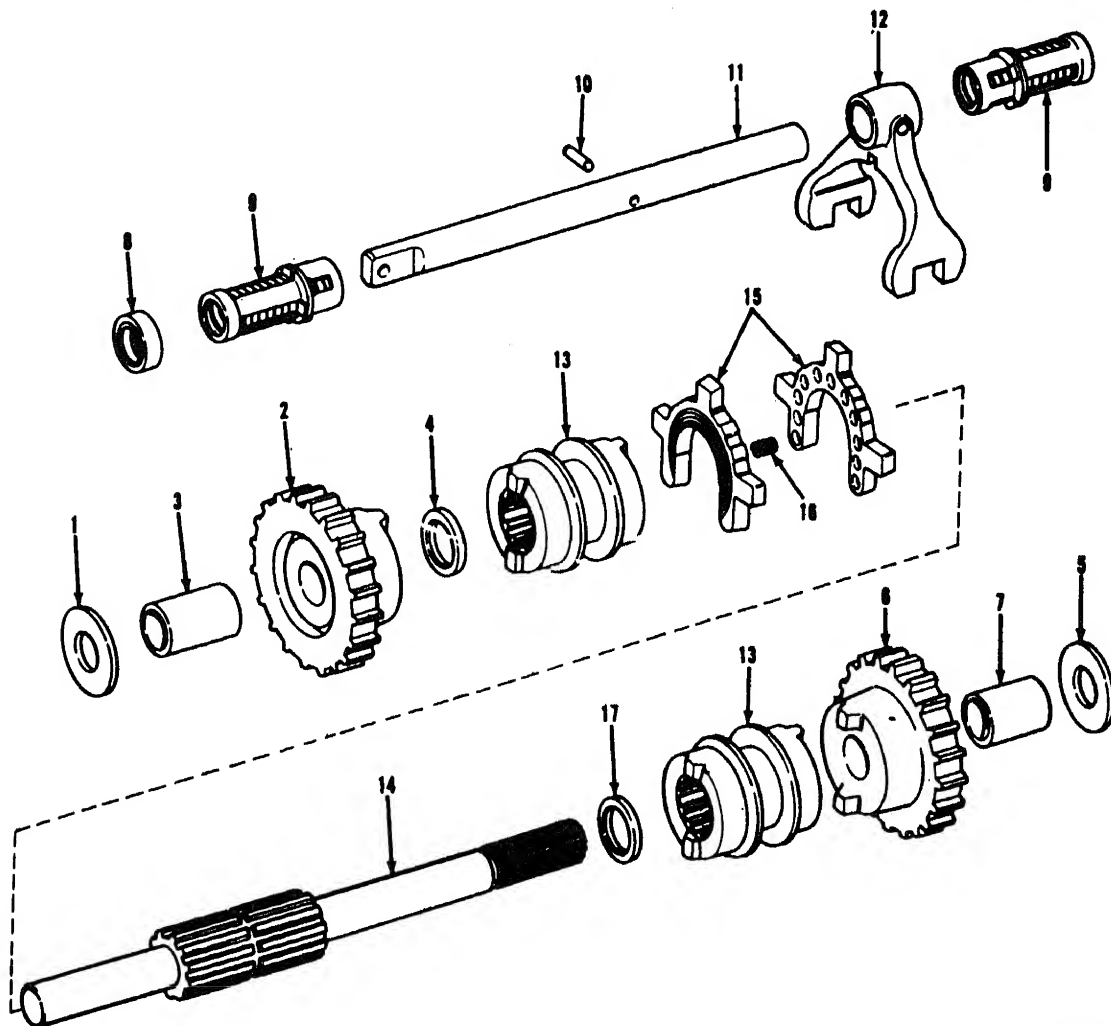
The power control unit consists of the power control housing and clutches, power control column, and drive shaft. The unit controls operation of the blade, scarifier and leaning wheel. The power control unit is engine-driven by means of a drive shaft connected to the transmission output flange.

#### 5-2. Blade Lift Control Clutches

a. *Removal.* Refer to paragraph 2-10.

b. *Disassembly.* (fig. 5-1.)

(1) Remove the washer (1) and pull the gear (2) from the clutch output shaft (14). Remove the bearing (3) and seal (4).



(2) Remove the washer (5), pull the gear (6), and remove the bearing (7).

(3) Remove the seal (8) and cartridge assemblies (9).

(4) Drive out the pin (10) and remove the shifter shaft (11).

(5) Remove the shifter fork (12).

(6) Remove the clutch (13) from the output shaft (14).

(7) Remove the pressure plates (15), eleven springs (16) and seal (17) from the clutch.

*c. Cleaning.* Clean all components except bearings in solvent and dry with compressed air. Clean bearings as instructed in paragraph 2-6.

*d. Inspection and Repair.*

(1) Inspect the bearings (3 and 7, fig. 5-1) and bearing contact surfaces on the output shaft (14). Repair surfaces as required.

(2) Inspect the shafts (11 and 14) for scratches, nicks, scores, pitting and other surface damage. Repair or replace as necessary.

(3) Inspect the springs (16) for weak or cracked condition and replace as necessary.

(4) Inspect pressure plates (15) for wear, damage or distortion. Replace if necessary.

(5) Inspect all metal parts for cracks, chips, excessive or uneven wear, and other damage. Replace any parts which cannot be repaired.

*e. Reassembly.* Assemble the clutch in the reverse order of disassembly. Peen the ends of the pin (10, fig. 5-1) when it is installed.

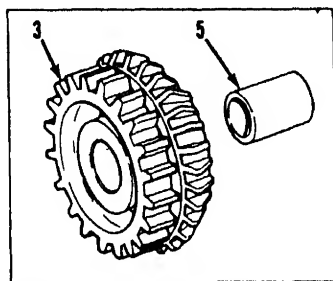
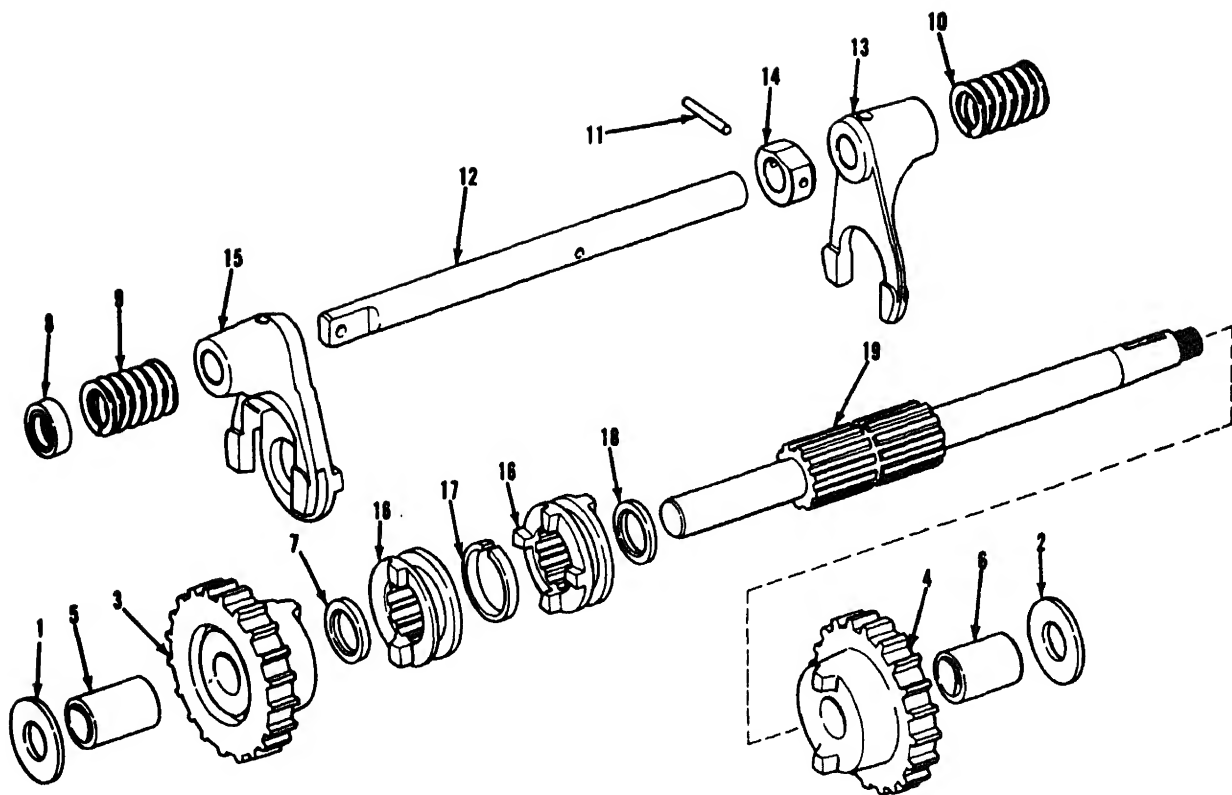
*f. Installation.* Refer to paragraph 2-10.

### 5-3. Scarifier, Circle Reverse, Sideshift and Leaning Wheel Clutches

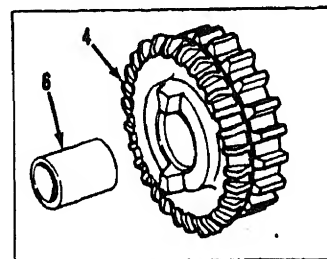
*a. Removal.* Refer to paragraph 2-10.

*b. Disassembly.* (fig. 5-2.)

(1) Remove the washers (1 and 2) and pull the gears (3 and 4) from the clutch output shaft (19). Remove the bearings (5 and 6) and seal (7).



ALTERNATE VIEW  
CIRCLE REVERSE CLUTCH



ALTERNATE VIEW  
CIRCLE REVERSE CLUTCH

ME 3805-249-34/5-2

1. Washer
2. Washer
3. Gear
4. Gear
5. Bearing
6. Bearing
7. Seal
8. Seal
9. Spring
10. Spring

11. Pin
12. Shaft
13. Fork
14. Collar
15. Fork
16. Clutch
17. Collar
18. Seal
19. Shaft

Figure 5-2. Scarifier, circle reverse and leaning wheel clutch, exploded view.

(2) Remove the seal (8) and springs (9 and 10) from the shifter shaft (12).

c. *Cleaning.* Clean all components except bearings in solvent and dry with compressed air.

(2) Inspect the springs (9 and 10) for weak or cracked condition. Replace as required.

(3) Inspect the shafts (12 and 19) for scratches, nicks, scores, pitting, and other surface damage and for wear. Repair surfaces as required.

(4) Replace any parts which are badly cracked, chipped, scratched, distorted or excessively worn.

*e. Reassembly.* Assemble the clutch in the reverse order of disassembly.

*f. Installation.* Refer to paragraph 2-10.

#### **5-4. Power Control Column**

*a. Removal.* Refer to paragraph 2-11.

*b. Disassembly.* (fig. 5-3.)

(1) Remove the bolts (1, 3 and 4) and lock-washers (2 and 5) and remove the bracket (6), cover (7) and gasket (8).

- 28. Lockwasher
- 29. Bracket
- 30. Shim
- 31. Pin
- 32. Coupling
- 33. Preformed packing
- 34. Cup
- 35. Cone
- 36. Nut
- 37. Yoke
- 38. Seal
- 39. Cage
- 40. Shim
- 41. Key
- 42. Shaft
- 43. Cap
- 44. Cone
- 45. Seal
- 46. Cotter pin
- 47. Nut
- 48. Bolt
- 49. Spring
- 50. Cover
- 51. Plug
- 52. Fitting
- 53. Housing

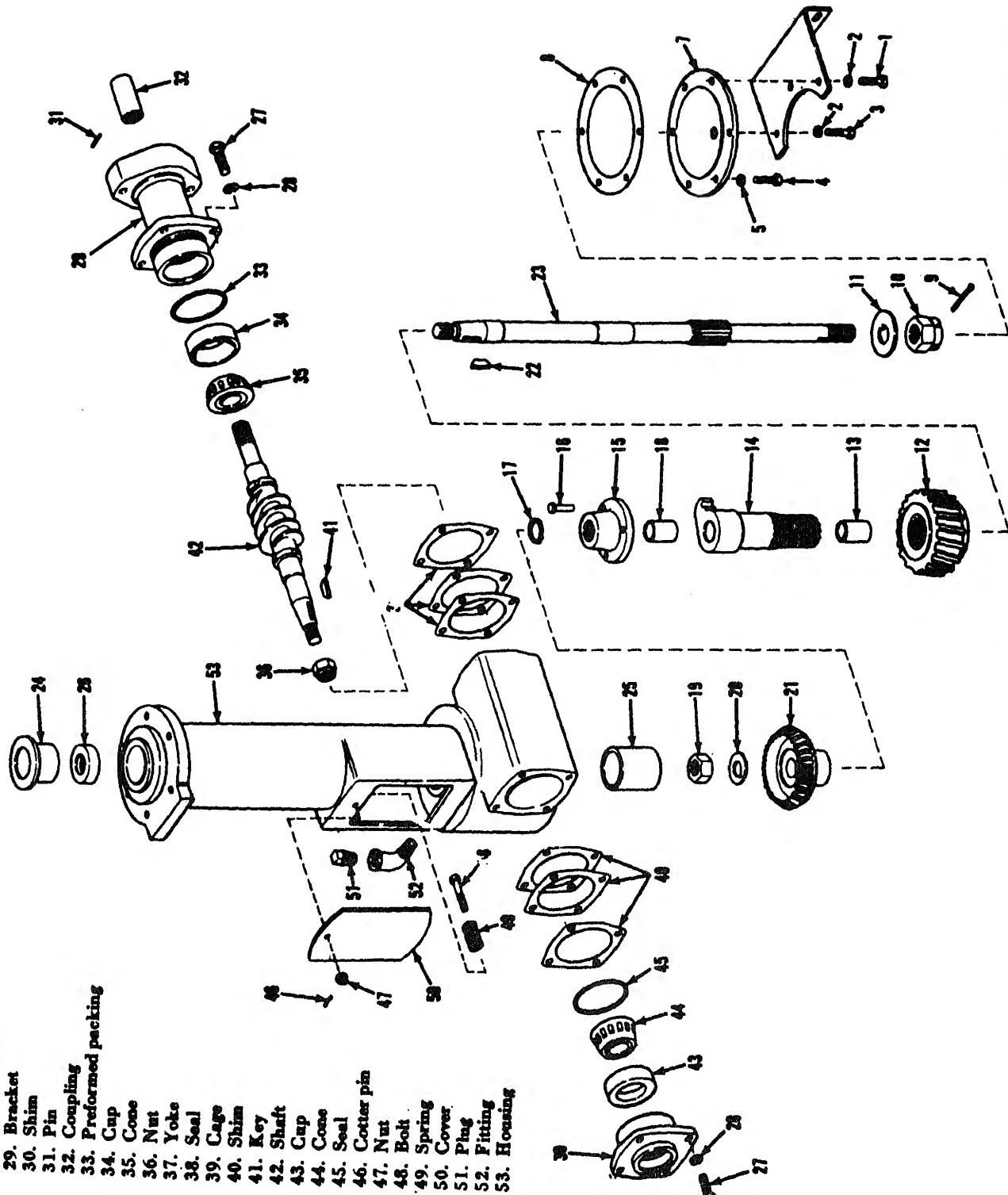


Figure 5-3. Power control column, exploded view.



(2) Remove the cotter pin (9), nut (10), and lock (11). Pull the gear (12) from the shaft (23) and remove the bearing (13).

(3) Pull the shaft (23) about halfway out of the housing and remove the lower coupling (14) and upper coupling (15) through the opening in the housing. Remove the pin (16), retaining ring (17) and bearing (18).

(4) Remove the nut (19), lock (20) and gear (21). Remove the key (22).

(5) Remove the shaft (23). Remove the upper bearing (24), lower bearing (25) and seal (26).

(6) Remove four bolts (27) and lockwashers (28) at each end of the worm gear housing. Remove the hydraulic pump mounting bracket (29) and shims (30). Remove the pin (31), coupling (32) and preformed packing (33).

(7) Remove the bearing cup (34) and cone (35).

(8) Remove the nut (36), yoke (37) and seal (38). Remove the cage (39), shims (40) and key (41).

(9) Pull the worm shaft (42) from the housing and remove the cup (43), cone (44) and seal (45).

(10) Remove the cotter pin (46), nut (47), bolt (48), spring (49) and cover (50). Remove the plug (51) and fitting (52) from the housing. (53).

*c. Cleaning.* Clean all components except bearings in solvent and dry with compressed air. Clean bearings as instructed in paragraph 2-6.

*d. Inspection and Repair.*

(1) Inspect gears, pinion and worm for nicks,

scratches, scores, pitting and other surface damage and for wear. Smooth surfaces with a hone or crocus cloth if possible, or replace parts as necessary.

(2) Inspect bearing surfaces for damage and uneven or excessive wear. Repair or replace as required.

(3) Replace damaged or deteriorated seals.

(4) Inspect metal parts for nicks, chips, cracks, scratches and other damage. Replace defective parts which cannot be repaired.

*e. Reassembly.* Assemble the power control column in the reverse order of disassembly. Observe the following:

(1) Install the seal (38, fig. 5-3) so that the spring-loaded lip is toward the bearing cone. Lubricate the lip.

(2) Install the bearing cage (39) without the shims (40). Tighten bolts (1, 3 and 4) evenly until all end clearance of the worm shaft (42) is removed. Measure the distance between the bearing cage and housing using a thickness gage. Install shims (40) between the cage and housing equal in thickness to the distance measured.

(3) Tighten the nut (19) to a torque of 80 to 100 foot-pounds.

(4) Tighten the nut (10) to obtain a clearance of 0.006 to 0.012 inch between the faces of coupling (14 and 15).

*f. Installation.* Refer to paragraph 2-11.

## Section II. BLADE LIFT, CIRCLE REVERSE AND CENTERSHIFT COMPONENTS

### 5-5. General

This section contains repair maintenance instructions for the controls and linkages which operate the blade. The controls include the blade lift assembly, circle transfer gear, circle reverse gear, and circle centershift control.

### 5-6. Blade Lift Assembly

*a. Removal.* Refer to paragraph 2-12.

*b. Disassembly.* (fig. 5-4.)

(1) Remove the bolts (1) and lockwashers (2) and remove the pinion shaft housing. Disassemble as follows:

(a) Remove the bolts (3 and 5), washers (4 and 7), nut (6) and spring (8). Remove the shoes (9) and linings (10).

(b) Remove the nut (11), lockwasher (12), washer (13), block (14) and seal (15).

(c) Remove the gear and shaft assembly from the housing. Remove the washer (16), gear (17), pin (18), coupling (19) and key (20) from the shaft (21).

(d) Remove the plug (22), and bushing (23) from the pinion shaft housing (24).

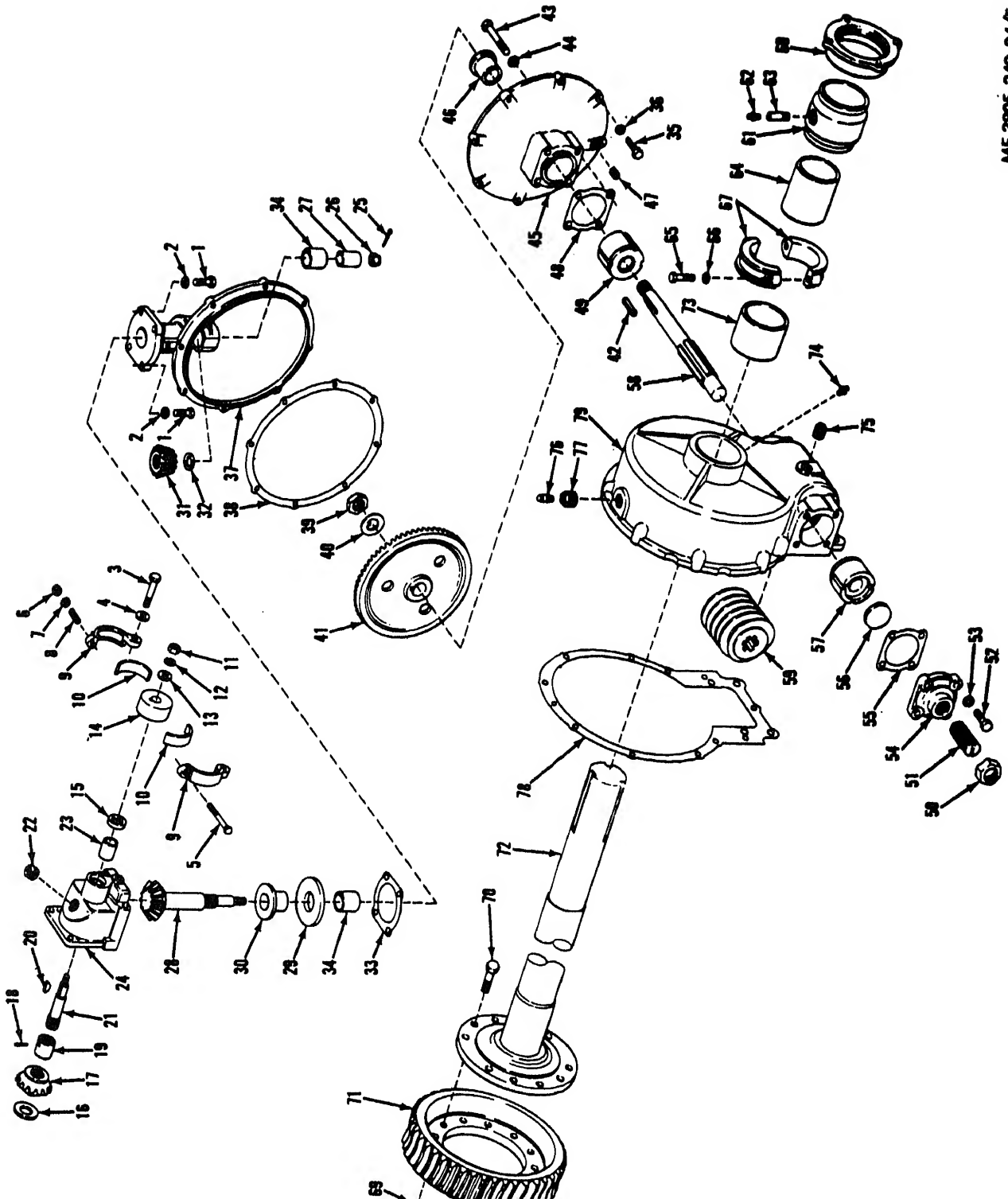


Figure 5-4. Blade lift assembly, exploded view.

**KEY to fig 5-4:**

1. Bolt
2. Lockwasher
3. Bolt
4. Washer
5. Bolt
6. Nut
7. Washer
8. Spring
9. Shoe
10. Lining
11. Nut
12. Lockwasher
13. Washer
14. Block
15. Seal
16. Washer
17. Gear
18. Pin
19. Coupling
20. Key
21. Shaft
22. Plug
23. Bushing
24. Housing
25. Cotter pin
26. Nut

27. Spacer
28. Pinion
29. Washer
30. Bushing
31. Gear
32. Washer
33. Gasket
34. Bushing
35. Bolt
36. Lockwasher
37. Housing
38. Gasket
39. Nut
40. Lock
41. Gear
42. Key
43. Bolt
44. Lockwasher
45. Cover
46. Bushing
47. Plug
48. Gasket
49. Bearing
50. Nut
51. Screw
52. Bolt
53. Lockwasher

54. Cover
55. Gasket
56. Plate
57. Bearing
58. Shaft
59. Worm
60. Cap
61. Bearing
62. Fitting
63. Extension
64. Bearing
65. Bolt
66. Lockwasher
67. Clamp
68. Nut
69. Lock
70. Bolt
71. Gear
72. Arm
73. Bushing
74. Plug
75. Plug
76. Plug
77. Fitting
78. Gasket
79. Housing

(2) Remove the cotter pin (25), nut (26) and spacer (27). Tap the end of the pinion (28) and remove from the housing. Remove the washer (29) and bushing (30). Lift out the gear (31) and washer (32). Remove the gasket (33) and bushings (34).

(3) Remove the bolts (35) and lockwashers (36), and remove the bevel pinion housing (37). Remove the gasket (38). Remove the nut (39), lock (40), bevel gear (41) and key (42).

(4) Remove the bolts (43), lockwashers (44) and cover (45). Remove the bushing (46), plug (47) and gasket (48). Remove the bearing (49).

(5) Remove the nut (50), adjusting screw (51), bolts (52), lockwashers (53), cover (54), gasket (55) and plate (56). Remove the bearing (57) and shaft (58). Lift out the worm (59).

(6) Remove the cap (60) and bearing (61). Remove the fitting (62) and extension (63) from the bearing. Remove the sleeve bearing (64).

(7) Remove the bolts (65), lockwashers (66) and clamp (67). Remove the lift arm and gear assembly from the housing. Bend back the locks (69) and remove the nuts (68), locks (69) and bolts (70). Remove the gear (71) from the lift arm (72).

(8) Remove the bushing (73), plugs (74, 75 and 76), fitting (77) and gasket (78) from the housing (79).

*c. Cleaning.* Clean all components except bearings with solvent. Dry with clean, lint-free cloths or with compressed air. Clean bearings as instructed in paragraph 2-6.

*d. Inspection and Repair.*

(1) Inspect the bearings and bearing control surfaces for excessive or uneven wear and for surface damage. Repair damage if possible or replace parts as necessary.

(2) Inspect pinion and gears for damaged or missing teeth. Replace damaged gears.

(3) Inspect shafts for scratches, nicks, scoring and excessive wear. Smooth surfaces with a hone or crocus cloth.

(4) Inspect housing and other metal parts for cracks and damage. Repair by welding.

*e. Reassembly.* Assemble in the reverse order of disassembly. Tighten the nut (39, fig. 5-4) to a torque of 275 to 310 foot-pounds.

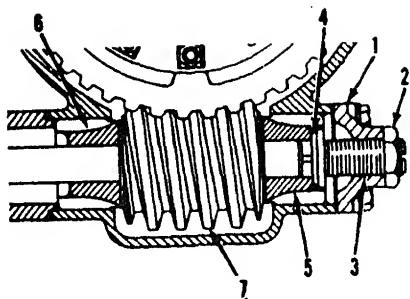
*f. Installation.*

(1) Install the blade lift assembly as instructed in paragraph 2-12.

(2) Adjust the worm (subpara g, below).

*g. Worm Adjustment.* (fig. 5-5.)

(1) With the cap (1) securely installed, loosen the locknut (2).



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Figure 5-5. Worm adjustment.

1. Cap
2. Locknut
3. Adjusting screw
4. Plate
5. Bearing
6. Bearing
7. Worm

(2) Turn the adjusting screw (3) against the plate (4) to remove the end clearance between the bearings (5 and 6) and the worm (7).

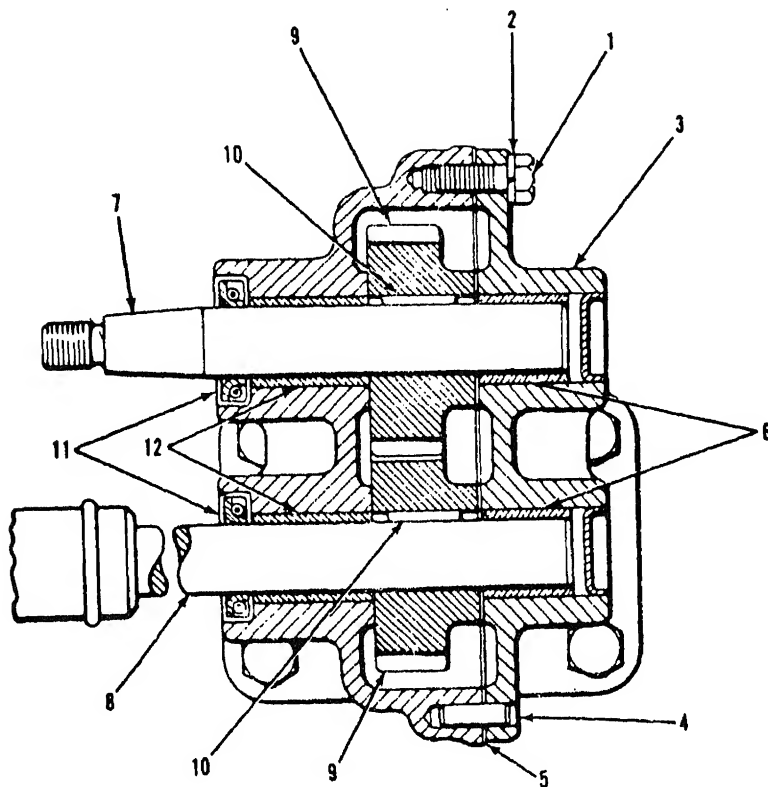
(3) Tighten the locknut (2) securely.

#### 5-7. Circle Transfer Gear

a. Removal. Refer to TM5-3805-249-12.

b. Disassembly. (fig. 5-6.)

(1) Remove bolts (1) and lockwashers (2) and remove the cover (3) from the housing. Remove pins (4) and scrape off the gasket (5).



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1. Bolt
2. Lockwashers
3. Cover
4. Pin
5. Gasket
6. Bushing

8. Output shaft
9. Gear
10. Key
11. Seal
12. Bearing
13. Housing

(2) Remove the bushings (6) from the cover.  
 (3) Remove the input shaft (7) and output shaft (8). Pull the gears (9) and remove the keys (10).

(4) Remove the seals (11) and the bearings (12) from the housing (13).

**c. Cleaning, Inspection and Repair.**

(1) Clean all components except the bearing in solvent. Dry with clean, lint-free cloths or with compressed air. Clean the bearing as instructed in paragraph 2-6.

(2) Inspect the bearing for uneven or excessive wear and for surface damage. Repair or replace as necessary.

(3) Inspect gears for worn, damaged or missing teeth. Replace gears as necessary.

(4) Inspect the shafts for scores, scratches and wear. Repair surface damage or replace as necessary.

**d. Reassembly.** Assemble the transfer gear in the reverse order of disassembly. Observe the following:

(1) Install the gears (item 9, fig. 5-6) with the long hubs towards the cover.

(2) Install the seals (11) with the spring-loaded lips toward the housing. Lubricate the lips.

(3) Ensure that the shafts and gears rotate without binding.

**e. Installation.** Refer to TM5-3805-249-12.

**5-8. Circle Reverse Gear Housing**

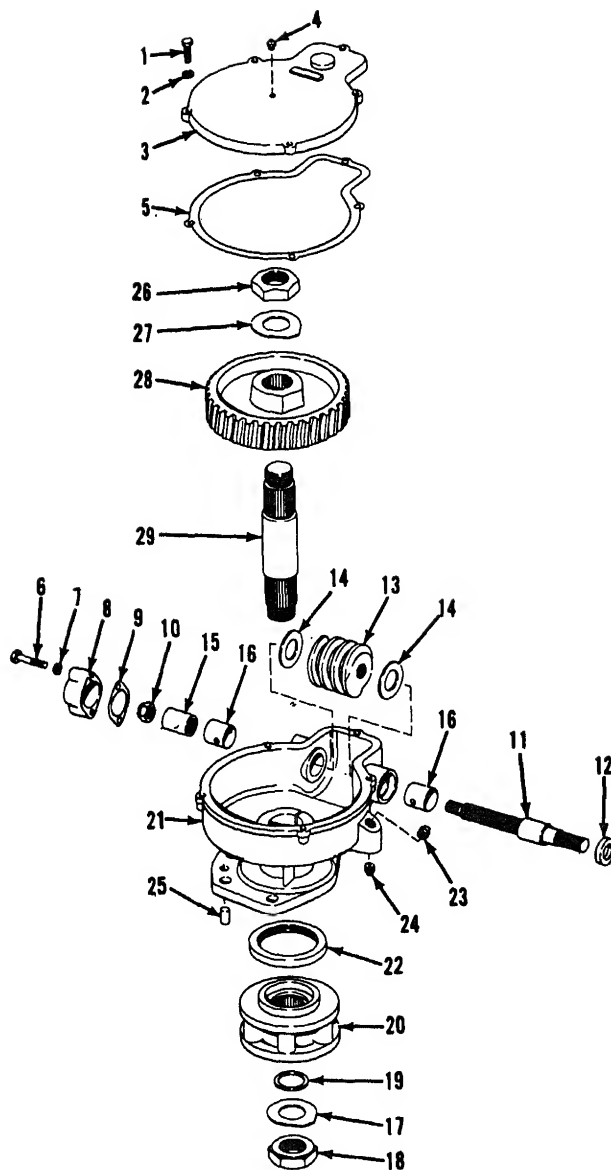
**a. Removal.** Refer to TM5-3805-249-12.

**b. Disassembly.** (fig. 5-7.)

(1) Drain the lubricant from the housing.

(2) Secure the base of the housing in a vise.

(3) Remove the bolts (1) and lockwashers (2) and remove the cover (3). Remove the fitting (4) and gasket (5).



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Figure 5-7. Circle reverse gear housing, exploded view.

**KEY to fig 5-7:**

1. Bolt
2. Lockwasher
3. Cover
4. Fitting
5. Gasket
6. Bolt
7. Lockwasher
8. Cap
9. Gasket
10. Nut
11. Shaft
12. Seal
13. Worm
14. Washer

15. Sleeve
16. Bearing
17. Lock
18. Nut
19. Seal
20. Pinion
21. Housing
22. Seal
23. Plug
24. Plug
25. Dowel
26. Nut
27. Lock
28. Gear
29. Shaft

(4) Remove the bolts (6) and lockwashers (7) and remove the cap (8) from the end of the worm shaft (11). Discard the gasket (9). Remove the nut (10).

(5) Using a soft hammer, tap out the worm shaft (11). Remove the seal (12).

(6) Lift out the worm (13) and two washers (14).

(7) Remove the sleeve (15) and bearings (16).

(8) Remove the housing from the vise. Turn the housing over.

(9) Flatten the lock (17), and remove the nut (18) and lock from the shaft. Remove the seal (19). Reinstall the nut so that it is flush with the end of the shaft. Loosen the pinion (20) using a hydraulic puller. Remove the pinion and the nut from the shaft.

(10) Lift the housing (21) from the shaft. Remove the seal (22). Remove plugs (23 and 24) and dowels (25) from the housing.

(11) Remove the nut (26) and lock (27) securing the worm gear (28) to the shaft (29). Press the shaft from the worm gear.

**c. Cleaning.** Clean all parts except bearings in solvent. Dry with clean, lint-free cloths or with compressed air. Clean bearings as instructed in paragraph 2-6.

**d. Inspection and Repair.**

(1) Inspect bearings and bearing contact

surfaces for damage and for excessive or uneven wear. Smooth contact surfaces with a hone or crocus cloth. Replace worn bearings.

(2) Inspect gears for worn, damaged or missing teeth. Repair or replace as necessary.

(3) Inspect shafts for damage and wear. Repair or replace as required.

(4) Inspect housing cover and cap for cracks, chips and other damage. Repair as necessary.

**e. Reassembly. (fig. 5-7.)**

(1) Support the shaft (29) and press on the worm gear (28). Secure with the nut (26) and lock (27).

(2) Insert the shaft assembly into the housing (21). Install the seal (22) with the lip toward the housing. Install plugs (23 and 24) and dowels (25).

(3) Support the shaft and press on the pinion (20) until the clearance between the pinion and the housing is 0.010 to 0.020 inch. Install the seal (19), lock (17) and nut (18).

(4) At the opposite end of the housing, install the bearings (16). Install the sleeve (15) and one washer (14). Install the worm (13), the other washer (14), and the worm shaft (11). Install the seal (12) with the spring-loaded lip toward the inside.

(5) Secure the shaft with the nut (10). Install a new gasket (9) and the cap (8). Secure with bolts (6) and lockwashers (7).

(6) Install the gasket (5) and cover (3) with bolts (1) and lockwashers (2). Install the fitting (4).

**f. Installation. Refer to TM5-3805-249-12.**

**5-9. Circle Centershift Control**

**a. Removal.** Refer to TM5-3805-249-12.

**b. Disassembly. (fig. 5-8.)**

(1) Remove the cotter pin (1), and nut (2). Remove bolts (3) and lockwashers (4) and remove the cover (5).

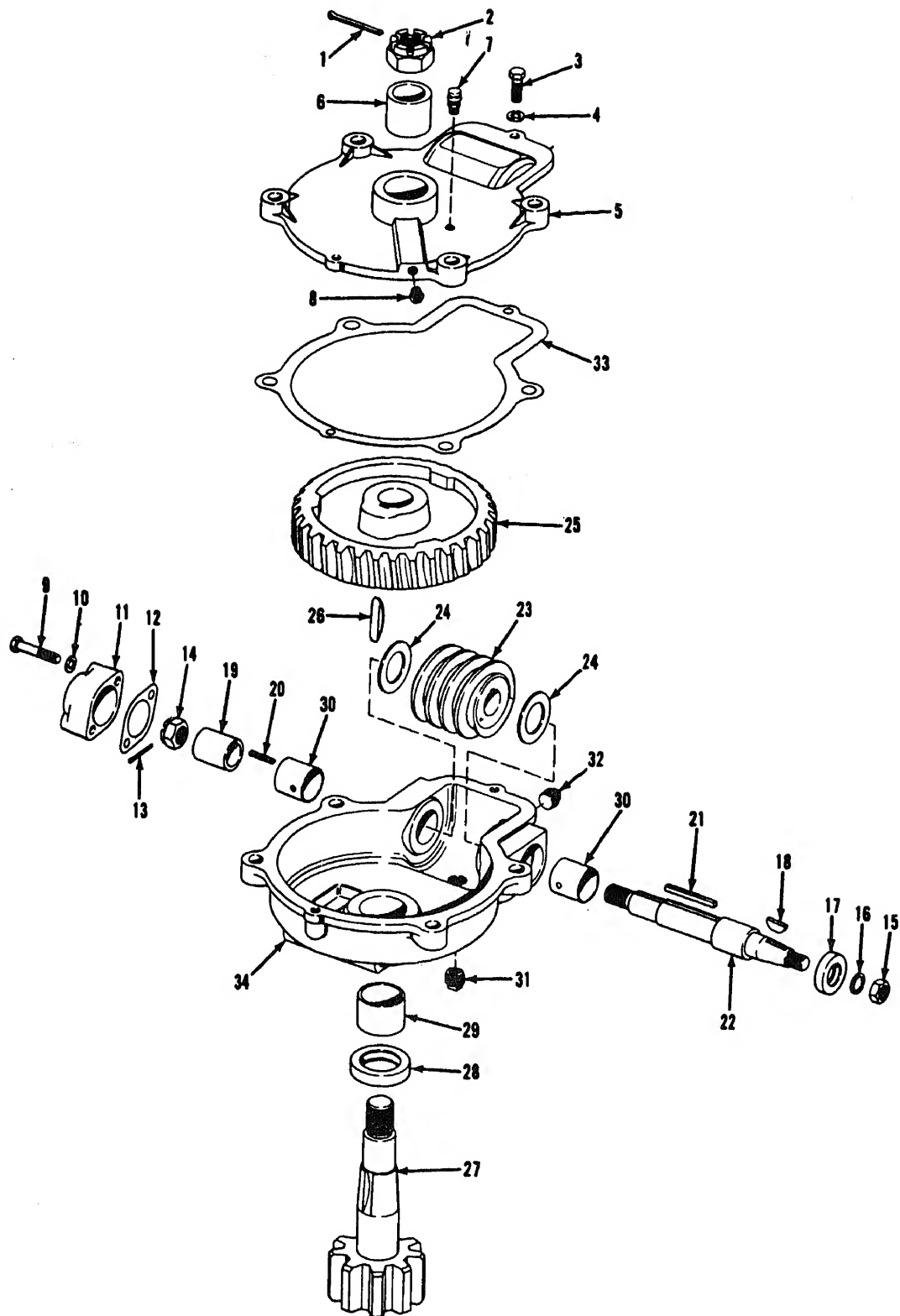


Figure 5-8. Circle centershift control: exploded view.

**KEY to fig 5-8:**

1. Cotter pin
2. Nut
3. Bolt
4. Lockwasher
5. Cover
6. Sleeve
7. Plug
8. Plug
9. Bolt
10. Lockwasher
11. Cap
12. Gasket
13. Cotter pin
14. Nut
15. Nut
16. Lockwasher
17. Seal

18. Key
19. Sleeve
20. Key
21. Key
22. Shaft
23. Worm
24. Washer
25. Gear
26. Key
27. Pinion
28. Seal
29. Bearing
30. Bearing
31. Plug
32. Plug
33. Gasket
34. Housing

(2) Remove the sleeve (6) and plugs (7 and 8) from the cover.

(3) Remove the bolts (9), lockwashers (10), cap (11) and gasket (12). Remove the cotter pin (13) and nut (14) from the end of the shaft.

(4) Tap the end of the shaft (22) and drive it from the housing. Remove the nut (15), lockwasher (16), seal (17), key (18), sleeve (19) and keys (20 and 21) from the shaft (22).

(5) Lift out the worm (23) and washers (24).

(6) Remove the worm gear (25) and key (26). Remove the pinion (27) and seal (28).

(7) Remove the bearings (29 and 30), plugs (31 and 32) and gasket (33) from the housing (34).

*c. Cleaning.* Clean all components except bearings with solvent. Dry with clean, lint-free cloths or with compressed air. Clean bearings as instructed in paragraph 2-6.

*d. Inspection and Repair.*

(1) Inspect bearings for surface damage and

for excessive or uneven wear. Repair or replace as necessary.

(2) Inspect gears and pinion for damaged, worn or missing teeth. Replace as necessary.

(3) Inspect shafts for surface damage and wear. Smooth surfaces as required.

(4) Inspect housing, and cover for cracks, chips and other damage. Repair as required.

*e. Reassembly.* Assemble the housing in the reverse order of disassembly. Observe the following:

(1) Install the seals (17 and 28, fig. 5-8) with the lips facing inward.

(2) Install the sleeve (19) so that the groove aligns with the passage from the lubrication fittings.

*f. Installation.* Refer to TM5-3805-249-12.

### **Section III. SCARIFIER CONTROL**

#### **5-10. General**

The scarifier control housing, mounted on the top of the frame at the front end of the grader, operates the scarifier.

#### **5-11. Scarifier Control Housing**

*a. Removal.* Refer to TM5-3805-249-12.

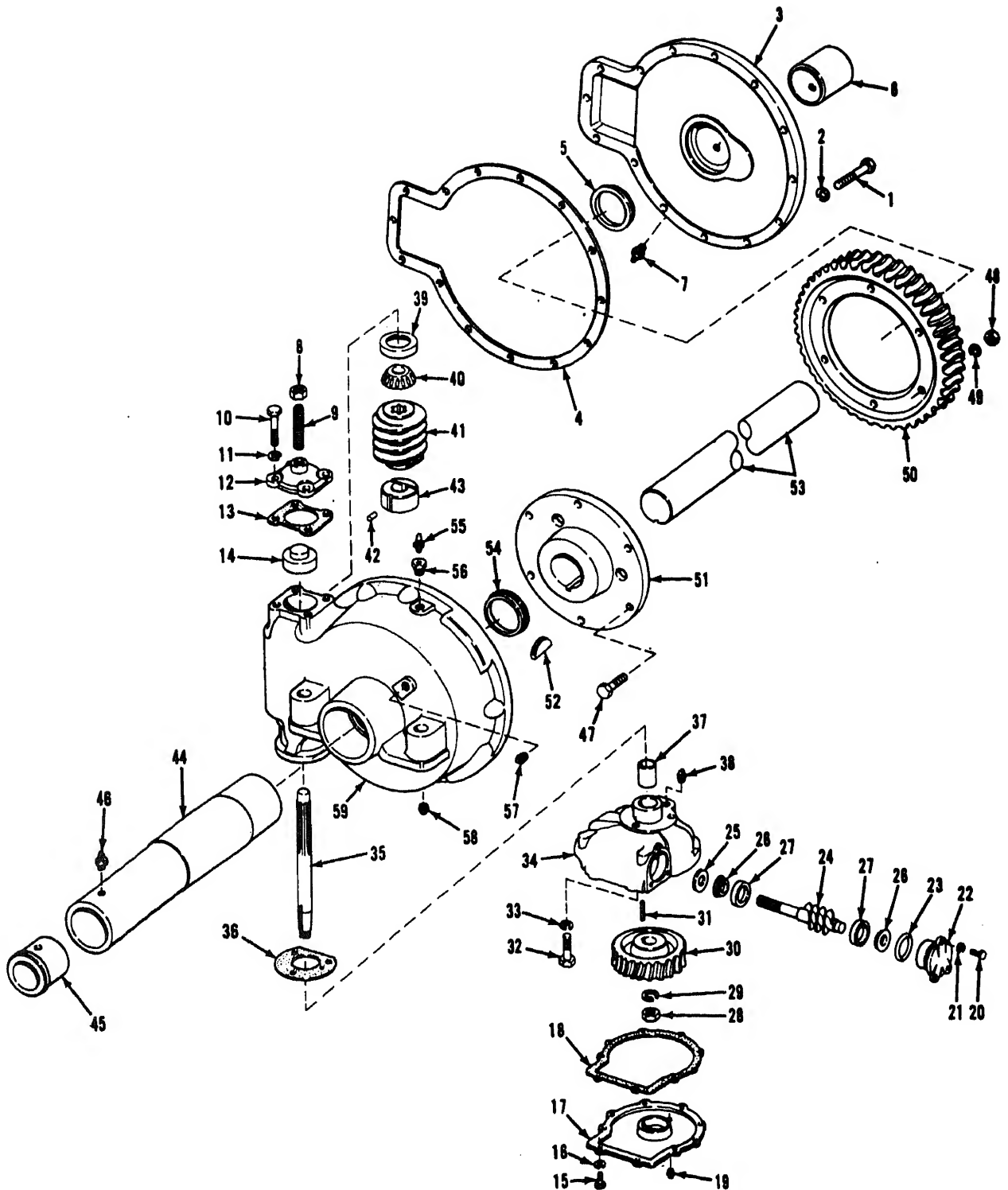
*b. Disassembly.* (fig. 5-9.)

*Note.* The scarifier control housing may be disassembled while it is removed from or installed on the grader.

(1) Drain the lubricant from the housing.

(2) Remove the bolts (1) and lockwashers (2) and remove the cover (3) from the housing. Remove the gasket (4), seal (5), bearing (6) and fitting (7).





**KEY to fig 5-9:**

1. Bolt
2. Lockwasher
3. Cover
4. Gasket
5. Seal
6. Bearing
7. Fitting
8. Locknut
9. Screw
10. Bolt
11. Lockwasher
12. Cover
13. Gasket
14. Follower
15. Bolt
16. Lockwasher
17. Cover
18. Gasket
19. Plug
20. Bolt
21. Lockwasher
22. Cap
23. Seal
24. Worm
25. Seal
26. Cone
27. Cup
28. Nut
29. Lockwasher

30. Gear
31. Key
32. Bolt
33. Lockwasher
34. Housing
35. Shaft
36. Gasket
37. Bearing
38. Fitting
39. Seal
40. Cone
41. Gear
42. Pin
43. Bearing
44. Shaft
45. Bushing
46. Fitting
47. Bolt
48. Nut
49. Lockwasher
50. Gear
51. Hub
52. Key
53. Shaft
54. Seal
55. Breather
56. Plug
57. Plug
58. Plug
59. Housing

(3) Remove the locknut (8) and adjusting screw (9). Remove the bolts (10), lockwashers (11), cover (12) and gasket (13). Remove the follower (14).

(4) Remove the bolts (15), lockwashers (16) and the lower housing cover (17). Discard the gasket (18). Remove the drain plug (19) if not previously removed.

(5) Remove the bolts (20) and lockwashers (21) and remove the cap (22). Remove the seal (23). Remove the worm (24) from the housing and remove the seal (25). Remove the cones (26 and cups (27).

(6) Remove the retaining nut (28) and lockwasher (29). Remove the gear (30) and key (31) from the shaft (35).

(7) Remove the bolts (32) and lockwashers (33) and remove the lower scarifier housing (34). Remove the shaft (35), gasket (36), bearing (37) and fitting (38).

(8) Remove the seal (39), cone (40), worm gear (41), pin (42) and bearing (43).

(9) Remove the shaft (44), bushing (45) and fitting (46).

(10) Remove the gear (50) and shaft (53) from the housing as an assembly.

(11) Remove the bolts (47), nuts (48) and

c. *Cleaning.* Clean all components except bearings with solvent. Dry with clean, lint-free cloths or with compressed air. Clean bearings as instructed in paragraph 2-6.

*d. Inspection and Repair.*

(1) Inspect all metal parts for cracks, chips, dents, scratches, and other surface damage and for wear. Repair or replace parts as necessary.

(2) Inspect bearings and bearing contact surfaces for damage and excessive or uneven wear. Smooth contact surfaces with a hone or crocus cloth. Replace bearings if necessary.

(3) Inspect gears for broken, missing or badly damaged teeth. Replace gears which cannot be repaired.

(4) Inspect shafts for dents, distortion and worn or damaged surfaces. Repair or replace as required.

(5) Replace damaged or deteriorated seals.

*e. Reassembly.* (fig. 5-9.)

(1) Install the seal (54) with the lip toward the gear (50).

(2) Press the key (52) into the shaft (53). Heat the hub (51) and shrink-fit onto the shaft. Interference fit between the shaft and hub must be 0.003 to 0.008 inch. The dimension from the edge of the hub to the end of the shaft must be 29.62

(5) Aline the key (31) with the keyway on the shaft (35). Press on the gear (30) and secure with the retaining nut (28) and lockwasher (29). Install the shaft and gear assembly into the housing (34).

(6) Install the bearing (43), bearing cone (40) and worm (41). Aline the slot on the outside diameter of the bearing with the pin (42) in the housing to prevent the bearing outer race from rotating.

(7) Install the seal (39). Secure the lower housing (34) to the upper housing (59) with bolts (32) and lockwashers (33).

(8) Install the cups (27) and cones (26) on the worm (24). Install the seals (23 and 25) and insert the assembly into the housing. Install the cap (22) and secure with lockwashers (21) and bolts (20).

(9) Install a new gasket (18) and the lower housing cover (17). Secure with bolts (15) and lockwashers (16).

(10) Install the follower (14). Install a new gasket (13) and the cap (12). Secure with bolts (10) and lockwashers (11). Install the adjusting screw (9) and tighten just enough to remove worm end clearance. Tighten the locknut (8) securely.

(11) Install the seal (5) in the cover (3) and install a new gasket (4). Secure the cover to the housing with bolts (1) and lockwashers (2). Install the bearing (6).

(12) Install remaining plugs and fittings.

*f. Installation.* Refer to TM5-3805-249-12 and install the control housing. Service the upper and lower housings with lubricant.

## REPAIR OF EARTHMOVING EQUIPMENT

## Section I. SCARIFIER ASSEMBLY

## 6-1. General

The V-type scarifier, used to break up hard ground, is mounted on the forward frame between the front wheels and the blade. The scarifier is connected to the scarifier control housing by means of two lift arms and links and is connected to the frame by drawbar arms.

## 6-2. Scarifier

a. *Removal.* Refer to TM5-3805-249-12.

b. *Disassembly.* Remove the bolts and nuts securing the drawbar arms to the scarifier block (fig. 6-1). Remove the pins and drive out the teeth and shanks.

c. *Cleaning.* Clean components with a scrub brush and detergent. Rinse with clean water.

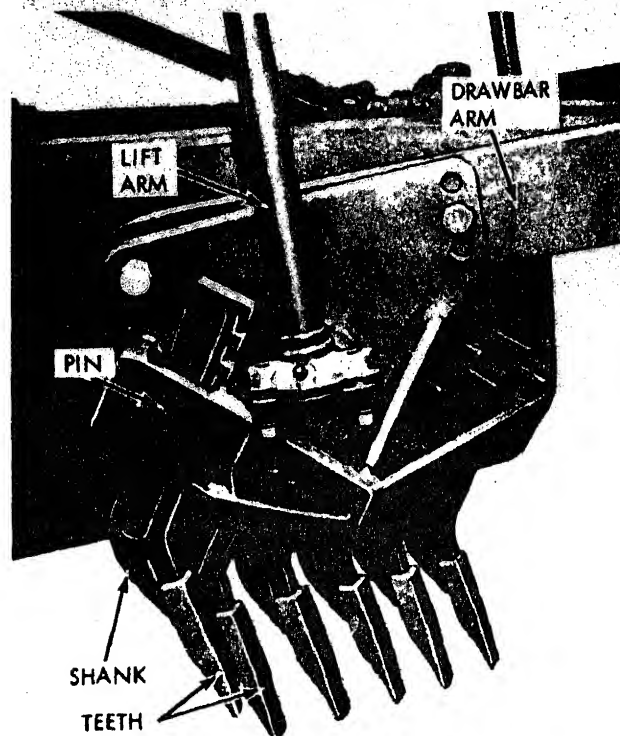
d. *Repair.*

(1) Replace badly damaged teeth.

(2) Inspect the block and drawbar arms for weld damage, and repair as necessary.

e. *Reassembly.* Assemble the scarifier in the reverse order of disassembly.

f. *Installation.* Install the scarifier assembly as described in TM5-3805-249-12. Lubricate the grease fittings.



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Figure 6-1. Scarifier.

## Section II. CIRCLE AND DRAWBAR ASSEMBLY

## 6-3. General

The circle assembly is a large gear which rotates to position the blade. The drawbar mounts the blade, and controls vertical movement.

## 6-4. Circle

a. *Removal.* Refer to paragraph 2-14.

b. *Cleaning, Inspection and Repair.*

(1) Clean the circle with a scrub brush and detergent. Rinse with clean water.

(2) Inspect the circle gear for badly damaged or missing teeth. Repair as necessary or replace the circle.

(3) Inspect the blade attachment points for flat spots or uneven wear. Smooth surfaces or replace damaged parts.

(4) Inspect for weld damage and repair as necessary.

c. *Installation.* Refer to paragraph 2-14.

## 6-5. Drawbar

Refer to paragraph 2-15 for removal and installation of the drawbar.

# CHAPTER 7

## REPAIR OF LEANING FRONT WHEEL AND FRONT AXLE COMPONENTS

### Section I. LEANING WHEEL CONTROL

#### 7-1. General

The leaning wheel is operated by a lever which is linked through a bevel pinion assembly to the control housing on the front axle. When the control lever is moved, the linkage shaft turns, rotating the gears in the bevel pinion case. This movement is in turn transferred to gears in the leaning wheel control housing. As these gears rotate, the leaning

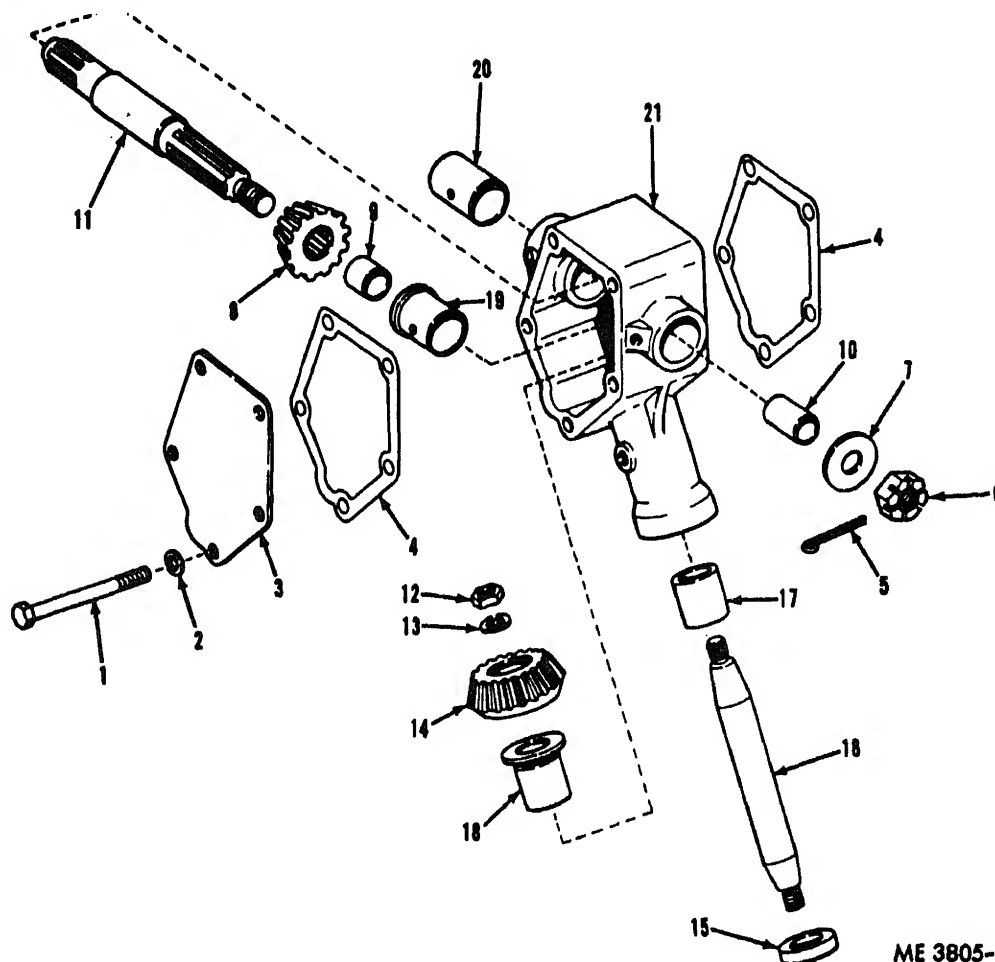
wheel tie bar is forced outward, and the front wheels lean.

#### 7-2. Bevel Pinion Case

a. *Removal.* Refer to TM5-3805-249-12.

b. *Disassembly.* (fig. 7-1.)

(1) Remove bolts (1) and lockwashers (2) securing the cover (3) to the case (15). Remove the cover and gaskets (4).



ME 3805-249-34/7-1

1. Bolt  
2. Lockwasher

7. Washer  
8. Gear

12. Nut  
13. Lockwasher

17. Bearing  
18. Bearing

(4) Remove the bearings (17, 18, 19 and 20) from the housing (21).

*c. Cleaning.* Clean all components except bearings in solvent. Wipe dry with a clean cloth. Clean bearings as instructed in paragraph 2-6.

*d. Inspection and Repair.*

(1) Inspect the gear teeth for cracks, chipping, burrs and other damage, and for wear. Remove burrs from the gear teeth with a soft stone or crocus cloth. Replace gears if wear is detectable by touch or exceeds 0.002 inch. Replace the gears as a set only.

(2) Inspect the housing and cover for wear, cracks, nicks, burrs and other visible damage. Replace if damage is excessive.

(3) Inspect the shafts for excessive or uneven wear, scratches, nicks, pitting and other damage. Remove burrs, scratches and light scoring with a crocus cloth or hone. Replace if badly damaged.

(4) Replace the oil seal if it is damaged or deteriorated.

*e. Reassembly.* Assemble the bevel pinion case in the reverse order of disassembly. Install the oil seal (15, fig. 7-1) so that the lip faces the case.

*f. Installation.* Refer to TM5-3805-249-12.

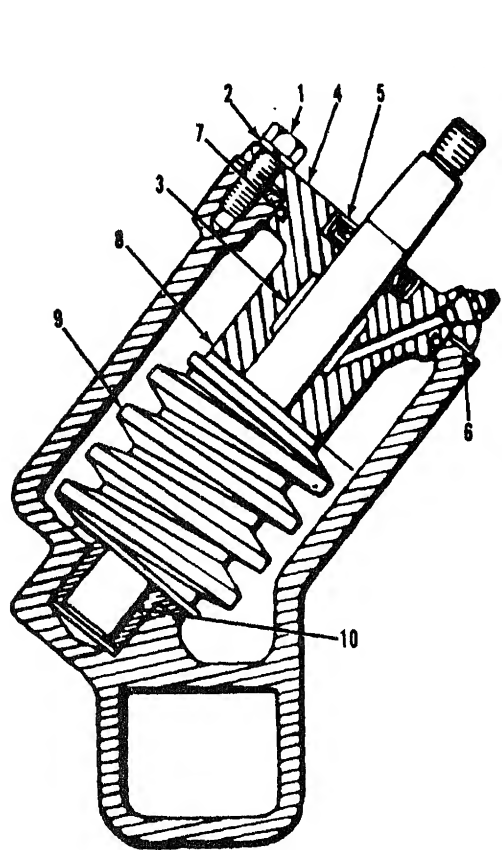
### 7-3. Leaning Wheel Control Housing

#### 1. Removal and Disassembly. (fig. 7-2.)

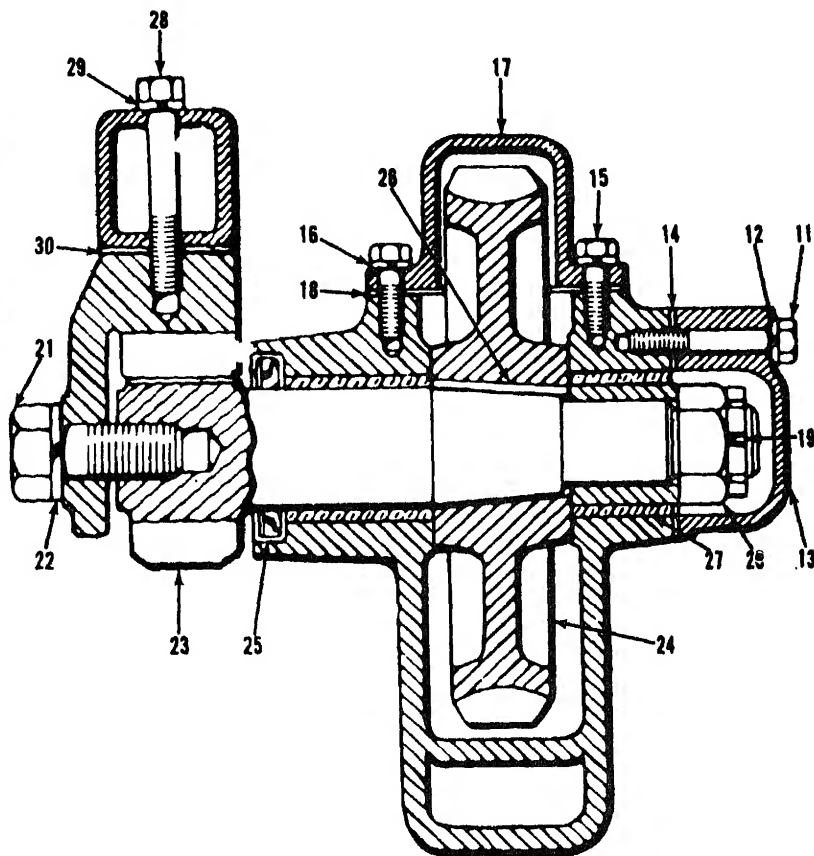
(1) With the front wheels straight ahead, lower the blade just enough to remove the weight of the vehicle from the front wheels. Do not raise the wheels off the ground.

(2) Remove the nut and washer which secure the yoke to the worm housing.

(3) Remove the filler plug and drain plug and allow the housing to drain.



SECTION THROUGH WORM



SECTION THROUGH GEAR

1. Bolt  
2. Lockwasher

9. Worm  
10. Shaft

17. Cover  
18. Gasket

25. Seal  
26. Key

the bearing (4) and remove the seal (5).

(5) Remove shims (6) and preformed packing (7).

(6) Rotate the worm assembly out of engagement with the worm gear, and lift the assembly out of the housing.

(7) Remove the washer (8).

(8) Remove the worm (9) from the shaft (10).

(9) Remove bolts (11) and lockwashers (12) and remove the cap (13). Discard the gasket (14).

(10) Remove bolts (15) and lockwashers (16) and remove the cover (17). Discard the gasket (18).

(11) Remove the cotter pin (19) and loosen but do not remove nut (20).

(12) Remove the bolt (21) and lockwasher (22).

(13) Pull the pinion (23) from the worm gear (29). Remove the nut (20).

(14) Remove the worm gear (24).

(15) Remove the seal (25), key (26) and sleeve (27) from the pinion.

(16) Remove the bolt (28), lockwasher (29), shims (30) and segment (31).

**b. Cleaning.** Clean all components except the bearing in solvent. Dry with a soft, clean cloth or blow dry with compressed air. Clean the bearing as instructed in paragraph 2-6.

#### **c. Inspection and Repair.**

(1) Inspect the bearing (4, fig. 7-2) for scratches, burrs, scores, nicks, pitting and other damage or wear. Replace or repair as required.

(2) Inspect the shaft (10) and pinion (23) for burrs, scratches and worn surfaces. Repair or replace as necessary.

(3) Inspect the worm (9) and worm gear (24) for burred and twisted teeth or splines, and for scratches, scores and other wear and damage. Replace badly damaged components.

(4) Replace damaged bolts, nuts, lockwashers, cotter pins and keys.

#### **d. Reassembly and Installation. (fig. 7-2.)**

(1) Install the seal (25) onto the pinion (23) so that the lip edge is away from the housing.

(2) Install the worm gear (24) and pinion (23) in the housing.

(3) Align the keyway in the worm gear with the keyway in the pinion, and install the key (26). Install lockwashers (22) and bolt (21).

(4) Install the sleeve (27) and tighten the nut (20). Install cotter pin (19).

(5) Install a new gasket (14) and the cap (13), and secure with lockwashers (12) and bolts (11).

(6) Install a new gasket (18) and the cover (17), and secure with lockwashers (16) and bolts (15).

(7) Install the seal (5) with the lip edge away from the bearing.

(8) Install the worm (9) on the shaft (10).

(9) Insert the worm assembly into the worm housing. Rotate the shaft until the worm engages the worm gear.

(10) Place the washer (8) on the worm and install the bearing (4) without installing the shims (6). Install the bolts (1) and tighten evenly just enough to remove end clearance. Measure the distance between the bearing and housing. The shims (6) to be installed should have a total thickness of 0.005 inch more than this distance.

(11) Remove the bearing and install shims (6) as necessary. Install the bearing and secure with lockwashers (2) and bolts (1).

(12) Press the key (3) into the worm shaft.

(13) Install shims (30) to produce zero backlash between the segment (31) and pinion (23). Install the segment and secure with bolts (28) and lockwashers (29).

(14) Secure the yoke to the worm housing with the nut and washer.

(15) Install the drain plug and service the housing. Install the filler plug.

(16) Raise the blade and operate the leaning wheel control through several cycles.

## **Section II. FRONT AXLE**

### **7-4. General**

The front axle assembly is designed with steering and leaning wheel capabilities. The axle serves not only as a mount for the front wheels but also as a mount for the shafts, rod, arm and housing which control the steer and lean.

### **7-5. Wheel Bearings**

#### **a. Removal.**

(1) Remove the wheels. Refer to TM5-3805-249-12.

(2) Using appropriate pullers and attachments, remove the inner bearing cone from the spindle and remove the seal.

(1) Clean the bearing cup and cone as instructed in paragraph 2-6.

(2) Inspect the bearing sections for flat spots, rough or uneven wear and for scratches, nicks, chips, scoring or other damage.

(3) Smooth surfaces with a soft hone or crocus cloth or replace if wear or damage is severe.

(4) Inspect the inner bearing cone seal and replace if damaged or deteriorated.

*c. Installation.*

(1) Repack the bearings. Refer to TM5-3805-249-12.

(2) Install the inner bearing cone seal on the

(3) Heat the cone in oil to no more than 250° F and install on the spindle.

(4) Chill the bearing cups and install in the wheel.

(5) Install and adjust the wheel. Refer to TM5-3805-249-12.

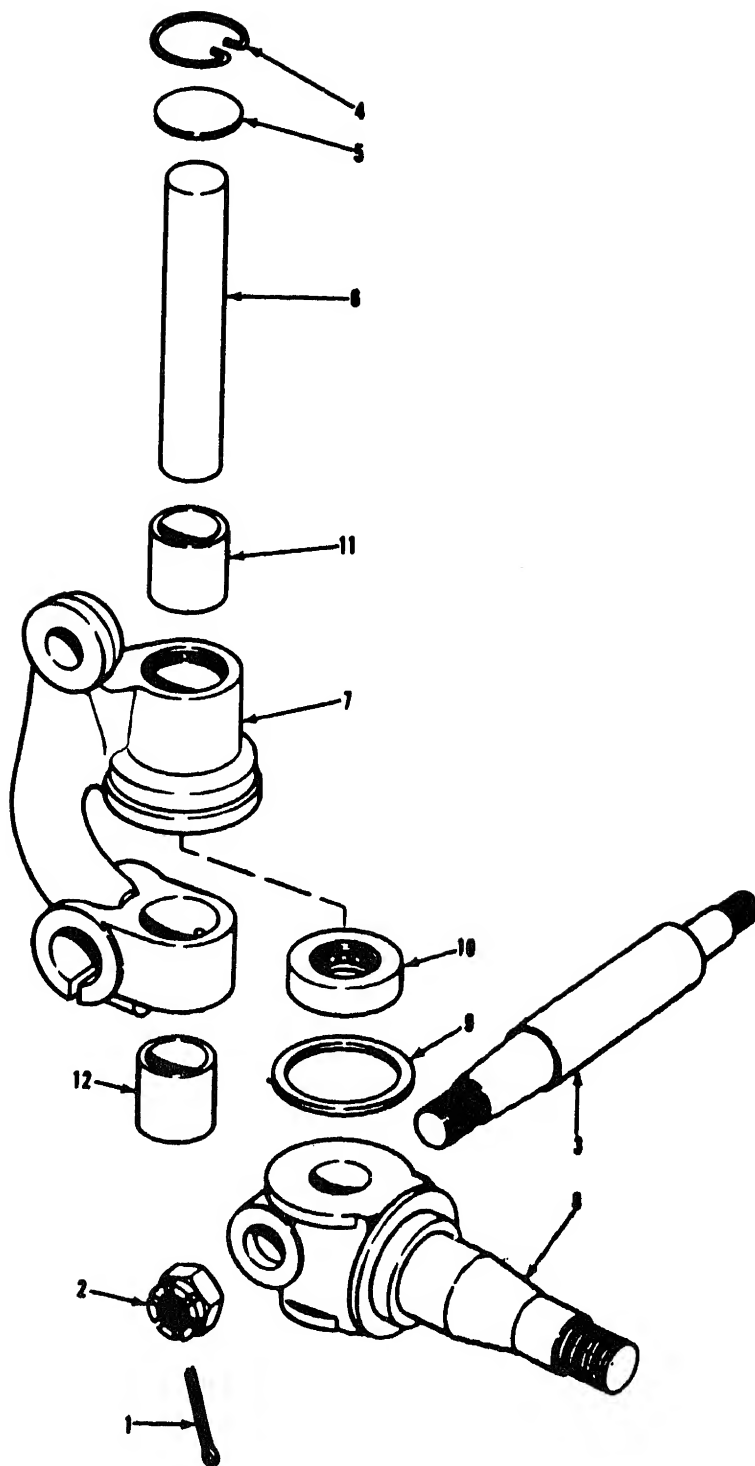
**7-6. Steering Knuckle and Leaning Wheel Arm**

*a. Removal.* Refer to TM5-3805-249-12.

*b. Disassembly.* (fig. 7-3.)

(1) Remove the cotter pin (1) and nut (2) securing the knuckle arm (3) to the steering knuckle.





ME 3805-249-34/7-3

1. Cotter pin

7. Leaning wheel arm

(3) Drive out the knuckle pin (6) and separate the leaning wheel arm (7) from the steering knuckle (8).

(4) Remove the seal (9) and the thrust bearing (10).

(5) Remove the bearings (11 and 12).

*c. Cleaning.* Clean all components except bearings in solvent. Wipe dry with a soft, clean cloth or blow dry with compressed air. Clean bearings as instructed in paragraph 2-6.

*d. Inspection and Repair.*

(1) Inspect all components for nicks, scratches, cracks, other damage, and for wear.

(2) Inspect bearings for flat spots and for excessive or uneven wear. Replace if necessary.

(3) Inspect the seal and replace if damaged or deteriorated.

*e. Reassembly.* (fig. 7-3.)

(1) Press the bearings (11 and 12) into the leaning wheel arm openings, aligning the holes in the bearings with the fittings in the leaning wheel arm.

(2) Install the thrust bearing (10) with the shielded side pressed into the counterbore of the leaning wheel arm. Install the seal (9).

(3) Assemble the steering knuckle (8) to the

in the steering knuckle.

(4) Install the plate (5) and retainer ring (4).

(5) Install the knuckle arm (3) and secure with the nut (2) and cotter pin (1).

*f. Installation.* Refer to TM5-3805-249-12.

**7-7. Front Axle Assembly**

*a. Removal.*

(1) Refer to paragraph 2-13 and remove the front axle assembly from the grader.

(2) Remove the steering knuckle and leaning wheel arm from the axle. Refer to TM5-3805-249-12.

*b. Repair.*

(1) Inspect bearings and bearing contact surfaces for rough or uneven wear and for flat spots. Smooth damaged bearing surfaces or replace bearings as necessary.

(2) Inspect the axle shaft for proper alignment.

(3) Inspect the axle for weld damage and repair as necessary.

*c. Installation.* Install the steering knuckle and leaning wheel arm as instructed in TM5-3805-249-12. Refer to paragraph 2-13 and install the front axle assembly.

# CHAPTER 8

## REPAIR OF STEERING AND HYDRAULIC SYSTEM COMPONENTS

### Section I. STEERING SYSTEM

#### 8-1. General

Steering system components are the steering wheel and column, steering gear and valve, pitman shaft, hydraulic cylinder, steering arm and tie rods.

The steering system is mechanically controlled with hydraulic assist. Turning the steering wheel rotates the levershaft, which, in turn, rotates the pitman shaft. Pitman shaft rotation produces angular movement of the pitman arm, which is connected through tie rods to the front wheels.

At the same time, steering wheel rotation positions the spool of the steering control valve. The control valve directs oil under pressure to the steering hydraulic cylinder. The cylinder also connects to the pitman arm, thus giving hydraulic assist to the steering.

#### 8-2. Steering Gear

##### a. Removal. (fig. 8-1.)

- (1) Position the front wheels in the straight ahead position.
- (2) Disconnect hydraulic lines at the steering control valve. Cap or plug openings.
- (3) Remove the key, nut and lockwasher connecting the shaft to the control valve.

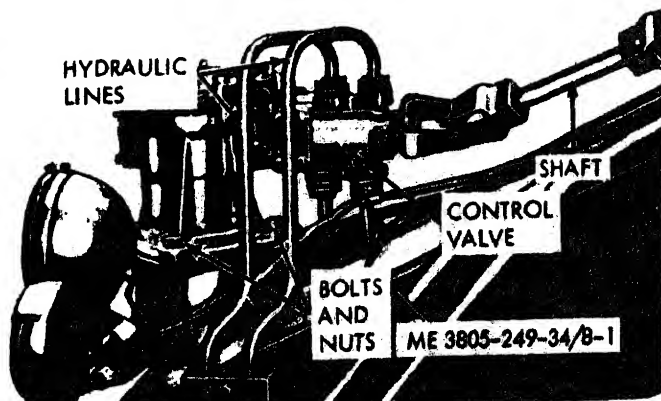
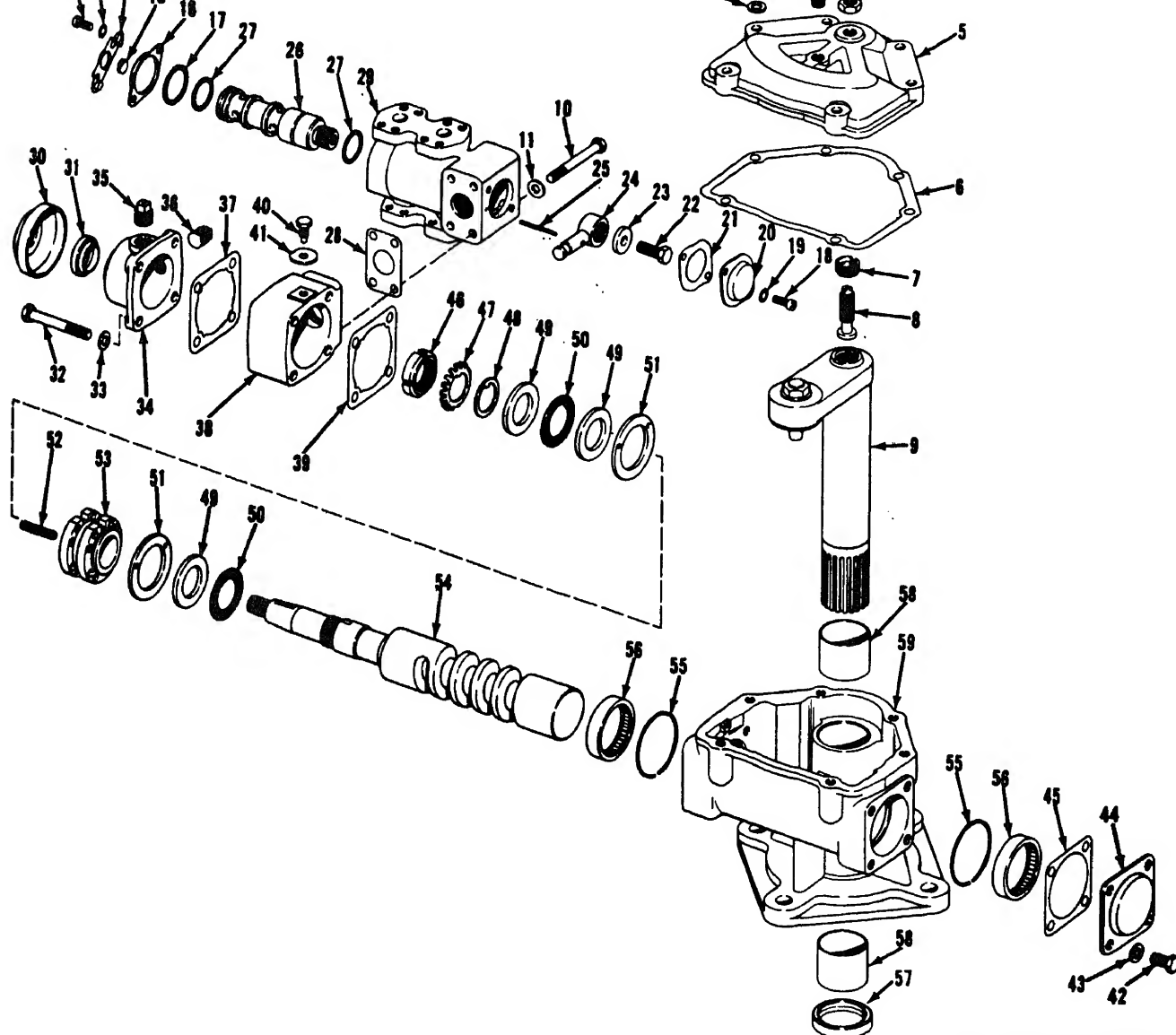


Figure 8-1. Steering gear assembly.

- (4) Remove the bolts and nuts, and remove the steering gear from the front end of the grader.

##### b. Disassembly. (fig. 8-2.)

- (1) Remove the plug (1).
- (2) Remove the bolts (2) and washers (3). Remove the adjusting screw locknut (4) and rotate the adjusting screw (8) clockwise. Lift off the cover (5). Remove the gasket (6).
- (3) Remove the retainer (7) and the adjusting screw (8).



ME 3805-249-34/8-2

- |                 |                |             |              |
|-----------------|----------------|-------------|--------------|
| 1. Plug         | 16. Cover      | 31. Seal    | 46. Nut      |
| 2. Bolt         | 17. Seal       | 32. Bolt    | 47. Lock     |
| 3. Washer       | 18. Screw      | 33. Washer  | 48. Washer   |
| 4. Locknut      | 19. Lockwasher | 34. Cover   | 49. Washer   |
| 5. Cover        | 20. Cover      | 35. Plug    | 50. Bearing  |
| 6. Gasket       | 21. Gasket     | 36. Plug    | 51. Washer   |
| 7. Retainer     | 22. Bolt       | 37. Gasket  | 52. Spring   |
| 8. Screw        | 23. Washer     | 38. Housing | 53. Actuator |
| 9. Pitman shaft | 24. Lever      | 39. Gasket  | 54. Shaft    |
| 10. Bolt        | 25. Pin        | 40. Bolt    | 55. Ring     |
| 11. Washer      | 26. Spool      | 41. Washer  | 56. Bearing  |
| 12. Screw       | 27. Seal       | 42. Bolt    | 57. Seal     |
| 13. Lockwasher  | 28. Gasket     | 43. Washer  | 58. Bearing  |
| 14. Retainer    | 29. Housing    | 44. Cover   | 59. Housing  |
| 15. Seal        | 30. Boot       | 45. Gasket  |              |

Figure 8-2. Steering gear assembly, exploded view.

Disassemble as follows:

(a) Remove the screws (12), lockwashers (13) and retainer (14). Remove the seal (15), cover (16) and seal (17).

(b) Remove the screws (18), lockwashers (19), cover (20), and gasket (21).

(c) Remove the bolt (22), washer (23), actuator lever (24) and pin (25).

(d) Remove the spool (26) and remove the seals (27) from the spool. Remove the gasket (28) from the housing (29).

(6) Remove the boot (30) and seal (31). Remove the bolts (32), washers (33) and cover (34). Remove the plugs (35 and 36), gasket (37), housing (38) and gasket (39). Remove the bolt (40) and washer (41) from the housing.

(7) Remove the bolts (42), washers (43), cover (44) and gasket (45).

(8) Remove the shaft from the housing. Remove the nut (46), lock (47), washers (48, 49 and 51), bearings (50), centering springs (52) and actuator (53) from the shaft (54).

(9) Remove the retaining rings (55), bearings (56), seal (57) and bearings (58) from the housing (59).

c. *Cleaning.* Clean all components except bearings in solvent. Wipe dry with clean cloths or dry with compressed air. Clean bearings as instructed in paragraph 2-6.

d. *Inspection and Repair.*

(1) Inspect the bearings and bearing cup for damage and excessive or uneven wear. Smooth surfaces with a soft hone or crocus cloth or replace as necessary.

(2) Inspect oil seals for damage and deterioration and replace as necessary.

(3) Inspect the housing and covers for cracks, chips and other damage. Repair or replace as required.

(4) Inspect the worm for cracks, chipping, burrs, scoring, and other damage and for wear. Replace the worm if wear is detectable by touch. Repair surface damage with a soft stone or crocus cloth.

(5) Inspect the worm shaft for excessive or uneven wear and for surface damage. Repair or replace as required.

e. *Reassembly.* Assemble the parts in the reverse order of disassembly. Observe the following:

(1) Lubricate the bearings (50, fig. 8-2) before installing on the shaft (54).

(2) Lubricate the seals (57) before installing.

(3) When installing the shaft (54) into the housing (59), tighten the nut (46) until a noticeable

of removal.

(2) Service the housing with lubricant. Refer to TM5-3805-249-12.

(3) Check the steering shaft for binding caused by misalignment. Adjust the alignment using setscrews in the bracket (fig. 8-1).

(4) Adjust the steering gear backlash as instructed in subparagraph g.

(5) Adjust the control valve as instructed in subparagraph h.

g. *Backlash Adjustment.*

(1) Raise the front of the grader until the tires clear the ground.

(2) Center the steering gear by turning the steering wheel from the extreme right to the extreme left, counting the number of turns. Then rotate the steering wheel exactly halfway.

(3) Loosen the adjusting screw locknut (4, fig. 8-2) and turn the adjusting screw (8) clockwise until the backlash in the steering gear is removed.

(4) Tighten the locknut.

h. *Control Valve Adjustment.*

(1) Raise the front wheels off the floor. Center the wheels in a straight-ahead position and ensure that the steering wheel is free to rotate.

(2) Prevent the spool (26, fig. 8-2) from turning by inserting a screwdriver into the slotted end of the spool. Loosen the locking bolt (22).

(3) Rotate the spool as required until the slotted end is flush with the face of the housing (29).

(4) Hold the spool in position and tighten the locking bolt.

8-3. *Lower Pitman Shaft*

a. *Removal and Disassembly.*

(1) Remove the steering gear (para 8-2). Remove the steering arm as instructed in TM5-3805-249-12.

(2) Lift out the lower pitman shaft.

(3) Remove the coupling, nut, lock, nut and washer from the shaft.

b. *Cleaning, Inspection and Repair.*

(1) Clean all components in solvent and dry with compressed air.

(2) Inspect the shaft gear teeth for nicks, burrs, cracks or other damage. Repair or replace as necessary.

c. *Reassembly and Installation.*

(1) Install the pitman shaft and washer. Install the steering arm as instructed in TM5-3805-249-12.

(2) Install the inner nut and tighten to remove shaft end clearance.

- (3) Install the lock, outer nut and coupling.
- (4) Install the steering gear (para 8-2).

#### 8-4. Steering Cylinder

##### a. Removal. (fig. 8-3.)

- (1) Remove the bolt and lockwasher securing the piston rod to the lower pitman shaft.
- (2) Turn the steering wheel to the extreme left position to retract the piston rod.
- (3) Remove four bolts and lockwashers securing each hydraulic line to the flange. Cap or plug openings.
- (4) Remove four bolts and lockwashers and one pin at the top and bottom of the cylinder and remove the cylinder.

##### b. Disassembly. (fig. 8-4.)

- (1) Drain any hydraulic oil trapped in the cylinder.
- (2) Remove four bolts (1) and lockwashers (2) securing the head assembly (3) to the cylinder housing.

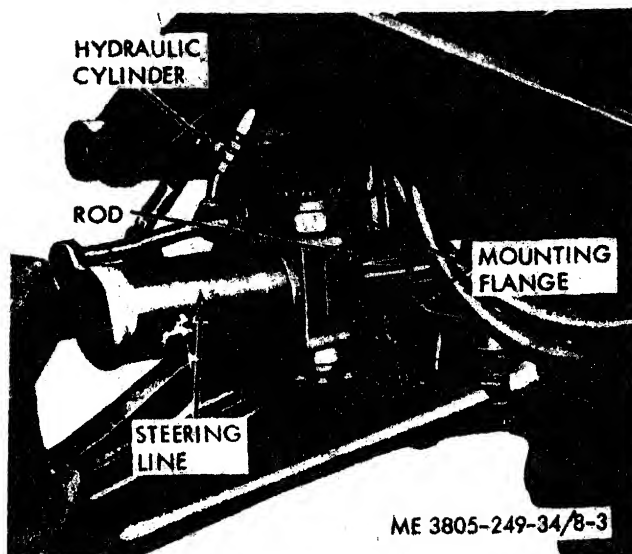
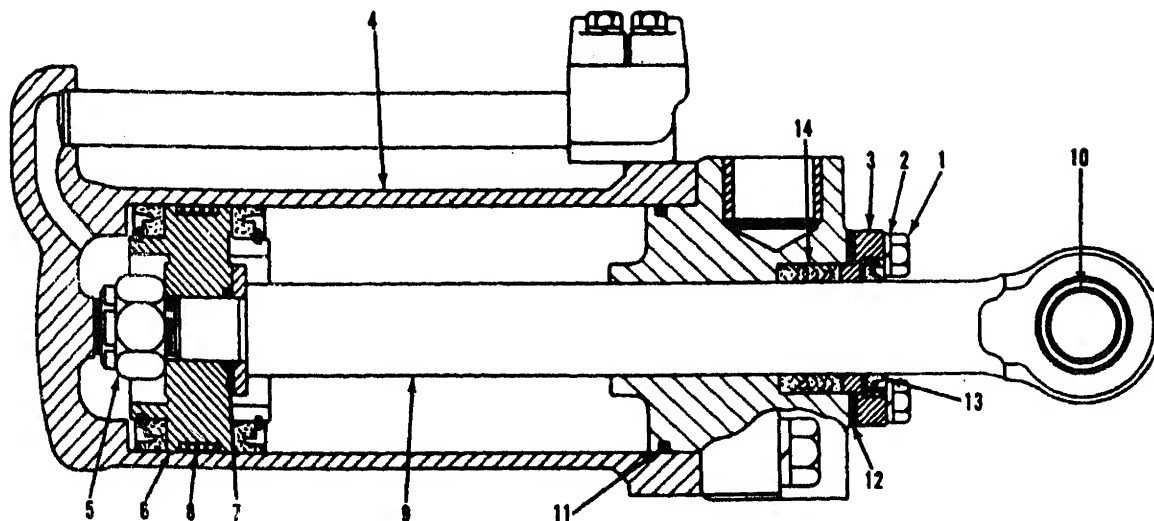


Figure 8-3. Steering cylinder.



ME 3805-249-34/8-4

1. Bolt
2. Lockwasher
3. Head assembly
4. Housing
5. Nut
6. Piston
7. Ring

8. Seal
9. Rod
10. Bearing
11. Ring
12. Seal
13. Seal
14. Bearing

Figure 8-4. Steering cylinder, cross section.

(3) Remove the head assembly and the piston rod assembly from the housing (4).

(4) Remove the nut (5) at the end of the piston rod. Remove the piston (6) and remove the ring (7) and seal (8).

(5) Remove the rod (9) from the head. Remove the bearing (10) from the rod eye.

(6) Remove the ring (11), seals (12 and 13) and bearing (14) from the head.

*c. Cleaning.* Clean all metal components except bearings in solvent. Dry with compressed air. Clean bearings as instructed in paragraph 2-6.

*d. Inspection and Repair.*

(1) Inspect parts for wear and damage and replace as necessary.

(2) Shine a light into the cylinder housing. Replace if it is severely grooved, scored or damaged.

(3) Inspect the piston rod for scores and other damage. Smooth the surface with a soft stone or crocus cloth.

(4) Replace bearings if they are unevenly or excessively worn.

(5) Replace deteriorated or damaged seals.

*e. Reassembly.* Assemble the cylinder in the reverse order of disassembly. Observe the following:

(1) Lubricate the seal (13, fig. 8-4).

(2) Lubricate the threads of the nut (5) and tighten to a torque of  $1000 \pm 120$  foot-pounds.

(3) Tighten the bolts (1) while the rod is fully extended.

*f. Installation.*

(1) Install the cylinder in the reverse order of removal. Tighten the pitman shaft nut to a torque of 300 to 340 foot-pounds.

(2) Check the hydraulic oil level and add as necessary.

(3) Start the engine and rotate the steering wheel through several complete cycles. Shut down the engine. Check for hydraulic leaks at the cylinder.

## Section II. HYDRAULIC SYSTEM

### 8-5. General

The hydraulic system consists basically of an oil supply tank, single section pump, pressure relief valve, oil filter, blade sideshaft control valve and blade hydraulic cylinder. The pump, driven by the power control worm gear shaft, delivers oil through the pressure relief valve to the oil filter. If the element is restricted, a bypass valve in the filter opens to allow oil to pass through the filter. Oil flows from the filter to the blade sideshaft control valve. The junction serves as a swivel joint for oil lines between the sideshaft control valve and the blade hydraulic cylinder. The pressure relief valve prevents excessive pressures from developing in the hydraulic system. Refer to figure 1-4 for the hydraulic system schematic diagram.

### 8-6. Hydraulic Pump

*a. Removal.* Refer to TM5-3805-249-12.

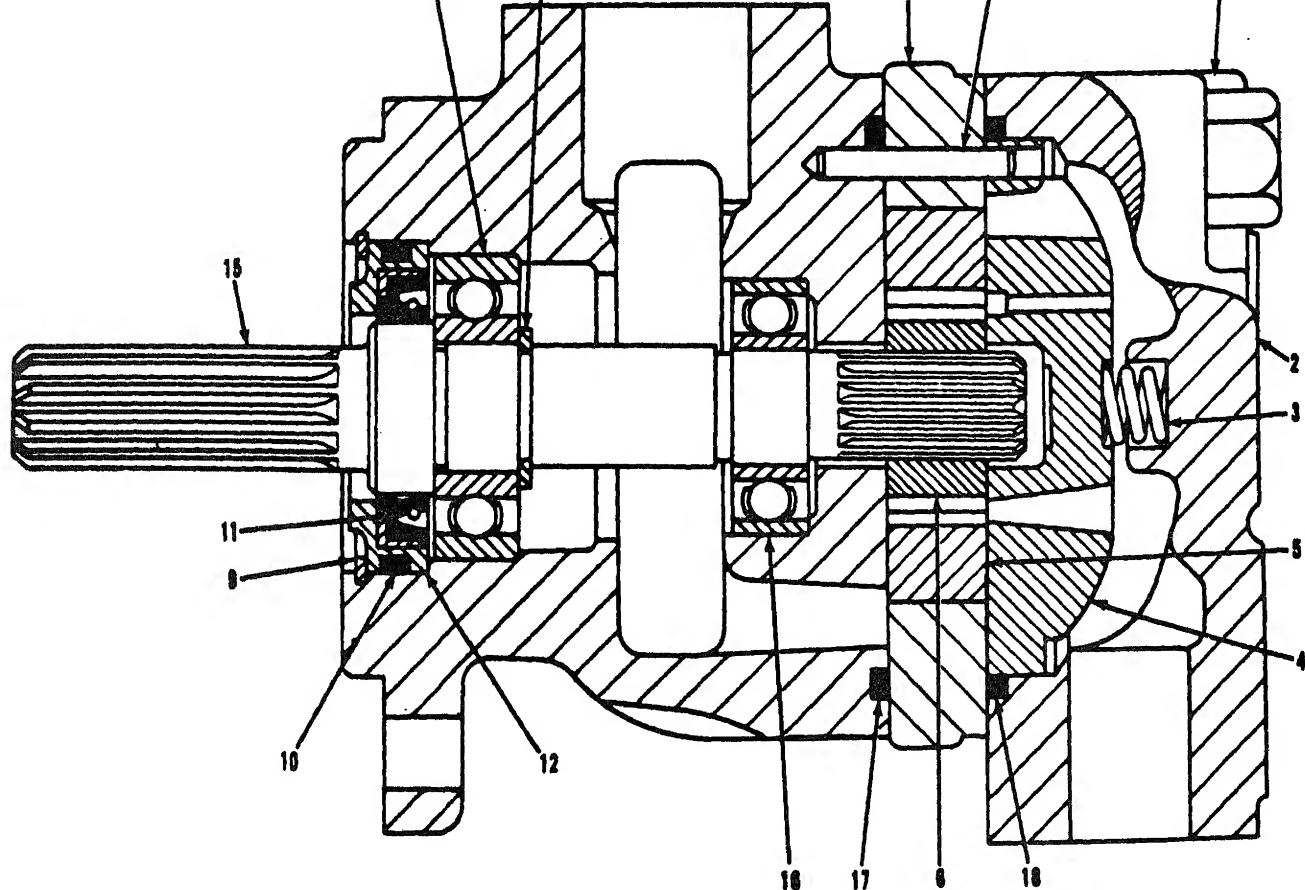
*b. Disassembly.* (fig. 8-5.)

*Note.* Ensure that work area, hands and tools are clean. Handle parts with care.

(1) Remove the relief valve from the pump housing as instructed in TM5-3805-249-12.

(2) Scribe a line down the length of the pump housing to aid in reassembly.

(3) Remove four bolts (1) and lift the cover (2) off the pump body.



ME 3805-249-34/8-5

1. Bolt
2. Cover
3. Spring
4. Pressure plate
5. Vane
6. Rotor
7. Pin
8. Ring
9. Retaining ring
10. Seal

11. Seal
12. Retainer
13. Snap ring
14. Bearing
15. Shaft
16. Bearing
17. Preformed packing
18. Preformed packing
19. Body

Figure 8-5. Hydraulic pump, cross section.

(4) Remove the spring (3), pressure plate (4), twelve vanes (5) and the rotor (6).

(5) Remove two pins (7) and separate the ring (8) from the body.

(6) Remove the pump shaft from the body. Remove the retaining ring (9), seals (10 and 11) and retainer (12). Remove the snap ring (13) and press the bearing (14) from the shaft (15). Remove the bearing (16).

(7) Remove the preformed packings (17 and 18) from the body (19) and cover (2).

#### c. Cleaning, Inspection and Repair.

(1) Clean all metal components except bearings with solvent and dry with compressed air. Clean bearings as instructed in paragraph 2-6.

(2) Inspect the vanes for damage and wear. If necessary, smooth with a fine stone.

(3) Inspect bearings for uneven or excessive wear. Smooth surfaces or replace as necessary.

(4) Inspect the shaft for scoring, pitting, nicks and other damage and for wear. Repair or replace as required.



order of disassembly, observing the following:

(1) Immerse each part in clean hydraulic oil as it is assembled.

(2) Insert the vanes (5, fig. 8-5) into the slots in the rotor (6) with the rounded edge toward the ring (8).

(3) Aline the marks made on the body, ring, and cover during disassembly.

(4) Install the ring (8) so that the arrow points clockwise when viewed from the large splined end of the shaft (15).

(5) Tighten cover retaining bolts (1) to a torque of 65 to 75 foot-pounds.

(6) After the pump is assembled, rotate the shaft (15) by hand. The shaft must not bind.

*e. Installation.* Refer to TM 5-3805-249-12.

### 8-7. Pressure Relief Valve

*a. Removal.* Refer to TM 5-3805-249-12.

*b. Disassembly.* (fig. 8-6.)

*Note.* Keep work area, hands and tools clean. Clean the exterior of the relief valve in solvent before disassembling.

(1) Remove the seal (1) from the base (2).

(2) Remove the dump valve (3) from the body (4).

- |           |            |
|-----------|------------|
| 3. Valve  | 11. Valve  |
| 4. Body   | 12. Spring |
| 5. Body   | 13. Spacer |
| 6. Spring | 14. Shim   |
| 7. Seal   |            |

(3) Separate the pilot valve body (5) from the body (4) and remove the spring (6) and seals (7 and 8).

(4) Remove the bolts and lockwashers and remove the retainer (9) from the pilot valve body.

(5) Remove the seal (10), pilot valve (11), spring (12), spacer (13) and shims (14).

*c. Cleaning, Inspection and Repair.*

(1) Clean all metal components in solvent. Dry with compressed air.

(2) Replace all seals and packings.

(3) Inspect the dump valve for nicks and burrs. Smooth the surface as required. Ensure that the valve slides freely in its bore in the body.

(4) Inspect the pilot valve and its seat in the body for nicks, burrs and grooves. Smooth as necessary or replace the valve.

*d. Reassembly.* Assemble the valve in the reverse order of disassembly. Install the same number of shims (14, fig. 8-6) as were removed. Tighten the bolts securing the retainer (9) to a torque of 24 to 30 foot-pounds.

*e. Installation.* Refer to TM 5-3805-249-12.

### 8-8. Hydraulic Junction

*a. Removal.* Refer to TM 5-3805-249-12.

*b. Cleaning, Inspection and Repair.*

(1) Clean all components in solvent.

(2) Replace preformed packings.

(3) Inspect the upper and lower faces and machined surfaces inside the housing and on the shaft. Remove any nicks, burrs or other rough spots with emery or crocus cloth.

(4) Lubricate the preformed packings.

*c. Installation.* Refer to TM 5-3805-249-12.

### 8-9. Sideshift Control Valve

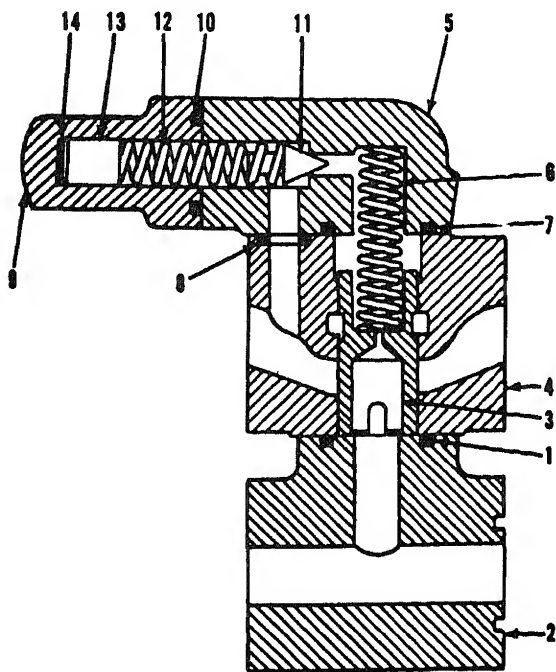
*a. Removal.* Refer to TM 5-3805-249-12.

*b. Disassembly.* (fig. 8-7.)

*Note.* Ensure that work area, hands, and tools are clean. Handle the valve carefully. Clean the valve exterior before disassembly.

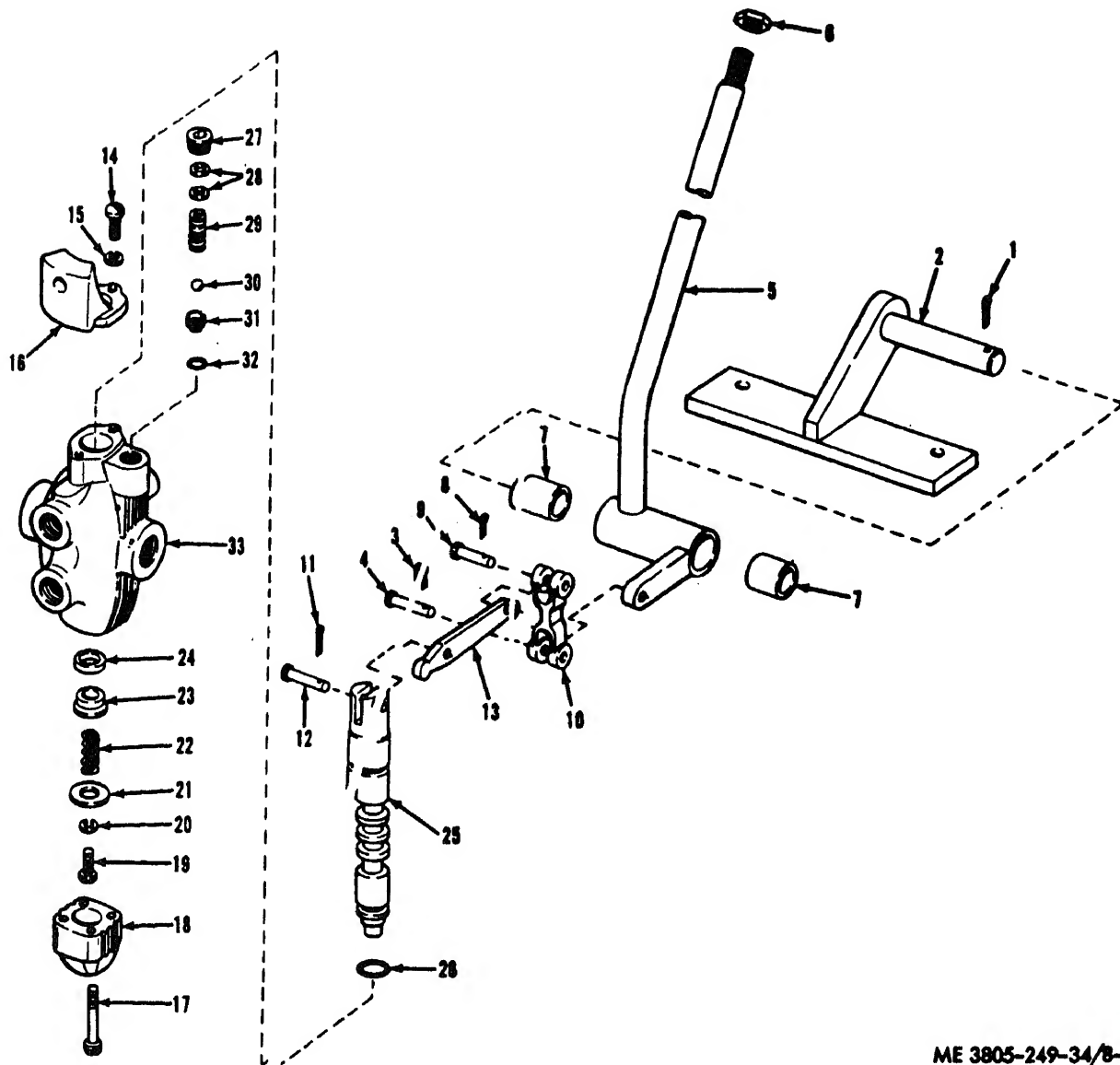
(1) Remove the cotter pin (1') and remove the plate assembly (2) from the handle. Remove the cotter pin (3) and pin (4) and remove the handle (5). Remove the nut (6) and bushings (7).

(2) Remove the cotter pin (8) and pin (9). Remove the yoke (10) from the lever. Remove the cotter pin (11) and pin (12) and remove the lever (13) from the spool.



ME 3805-249-34/8-6

Figure 8-6. Relief valve, cross section.



ME 3805-249-34/8-7

1. Cotter pin
2. Plate
3. Cotter pin
4. Pin
5. Handle
6. Nut
7. Bushing
8. Cotter pin
9. Pin
10. Yoke
11. Cotter pin
12. Pin
13. Lever
14. Capscrews
15. Lockwasher
16. Bracket
17. Screw

18. Bonnet
19. Screw
20. Lockwasher
21. Washer
22. Spring
23. Collar
24. Seal
25. Spool
26. Packing
27. Plug
28. Shim
29. Spring
30. Ball
31. Seat
32. Packing
33. Body

(3) Remove the capscrew (14), lockwasher (15) and control bracket (16).

(4) Remove the screws (17) and bonnet (18). Remove the adjusting screw (19), lockwashers (20), washer (21), spring (22) and collar (23).

(5) Push the spool (25) into the valve body until the seal (24) can be removed. Remove the seal and pull the spool out of the body. Remove the packing (26).

(6) Remove the plug (27), shims (28), spring (29), ball (30), seat (31) and packing (32) from the body (33).

*c. Cleaning.* Clean all components in suitable solvent.

*d. Inspection and Repair.*

(1) Inspect shafts for cracks, wear, distortion, or other damage. Replace if necessary.

(2) Inspect springs for cracks and improper tension. Replace as necessary.

(3) Inspect the housing and components for damage and wear. Replace defective parts.

(4) Replace all packings and seals.

(5) Remove any nicks or burrs from the valve using a soft stone or crocus cloth.

*e. Reassembly.* Assemble the valve in reverse order of disassembly. Install the same number of

shims (28, fig. 8-7) as were removed. The total thickness of these shims determines the pressure at which the bypass valve opens.

*f. Installation.* Refer to TM 5-3805-249-12.

## 8-10. Blade Hydraulic Cylinder

### *a. Removal.*

(1) Remove the blade as instructed in TM 5-3805-249-12.

(2) Attach a hoist to the hydraulic cylinder.

(3) Remove the retaining ring and pin which secure the rod eye to the bracket. Move the tilt bracket outward to clear the rod.

(4) Remove the retaining ring and pin which secure the closed eye to the bracket. Move the tilt bracket outward to clear the cylinder.

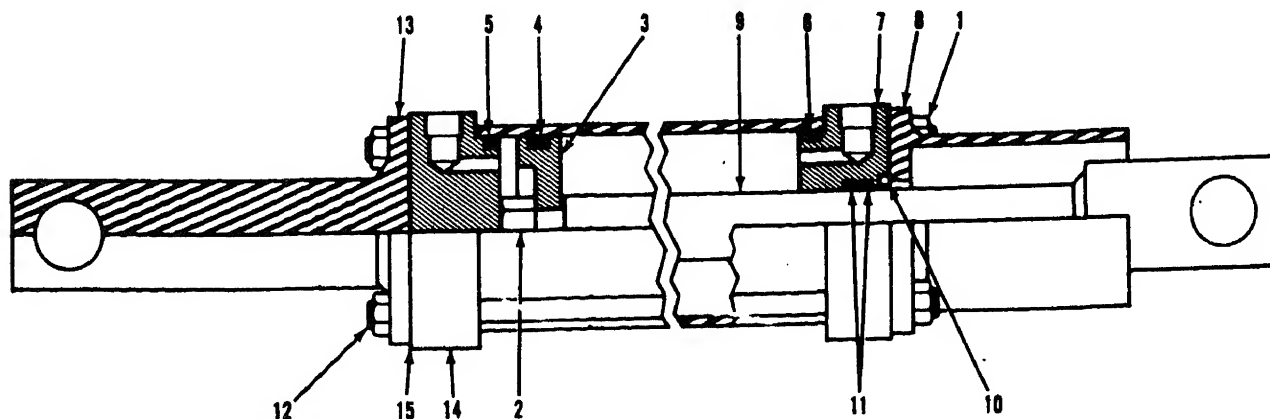
(5) Remove the cylinder.

### *b. Disassembly.* (fig. 8-8.)

(1) Drain hydraulic oil trapped in the cylinder.

*Caution:* Extend the rod before removing the head nuts to prevent possible scoring of the cylinder barrel walls.

(2) Remove four nuts (1) which secure the head to the cylinder. Remove the piston rod and head plate as an assembly.



ME 3805-249-34/8-8

1. Nut
2. Nut
3. Piston
4. Backup ring
5. Backup ring
6. Gasket
7. Head assembly
8. Head plate
9. Rod
10. Wiper ring
11. Preformed packing
12. Nut

(3) from the rod.

(4) Remove the backup rings (4 and 5) from the piston.

(5) Remove the gasket (6), head assembly (7), and head plate (8) from the piston rod (9).

(6) Remove the wiper ring (10) and two preformed packings (11) from the head assembly.

(7) Remove the nuts (12) and remove the cylinder barrel (13) from the cylinder base (14). Remove the preformed packing (15).

*c. Cleaning, Inspection and Repair.*

(1) Clean all components in solvent and dry with compressed air.

(2) Remove rough spots on the piston rod using crocus or fine emery cloth.

(3) Inspect the walls of the barrel bore for scoring. If scoring cannot be removed by honing lightly, replace the cylinder.

(4) Replace all packings and seals.

*d. Reassembly.* Assemble the cylinder in the reverse order of disassembly. Lubricate all seals and the cylinder barrel bore. Install the wiper ring (10, fig. 8-8) with the lip facing away from the preformed packings (11).

*e. Installation.*

(1) Install the cylinder by reversing the removal procedure.

(2) Install the blade as instructed in TM 5-3805-249-12.

(3) Check the hydraulic oil level and replenish as necessary.

(4) Start the engine and operate the blade sideshift through several complete cycles. Shut down the engine. Check for oil leaks at the cylinder fittings and piston rod.

(5) Check the hydraulic oil level and add as necessary.

**8-11. Hydraulic Reservoir**

*a. Removal.* Refer to TM 5-3805-249-12.

*b. Disassembly.* Remove 24 bolts, nuts and lockwashers securing the two halves of the tank together. Scrape off the gasket at the contact point.

*c. Cleaning, Inspection and Repair.*

(1) Clean the tank in solvent.

(2) Inspect the tank for damage and repair as required.

(3) Replace damaged hardware.

(4) Install a new gasket.

*d. Reassembly.* Assemble the reservoir in the reverse order of disassembly. Tighten nuts securely.

*e. Installation.* Refer to TM 5-3805-249-12.

# CHAPTER 9

## REPAIR OF FRAME COMPONENTS

### Section I. FUEL TANK AND SEAT

#### 9-1. Fuel Tank

a. *Removal.* Refer to TM 5-3805-249-12.

b. *Repair.*

(1) Flush the tank with solvent and rinse with fuel.

(2) Inspect tank for corrosion and weld damage and repair as required.

(3) Replace defective cap, strainer or drain valve.

c. *Installation.* Refer to TM 5-3805-249-12.

#### 9-2. Seat

a. *Removal.* Remove two hinge pins and remove the seat from the grader. Refer to figure 9-1.

b. *Repair.* Repair torn cover on the cushion or backrest with a cloth mending tape. Inspect the seat riser for dents and bends, and straighten as required. Straighten the seat adjustment paths if they are bent.

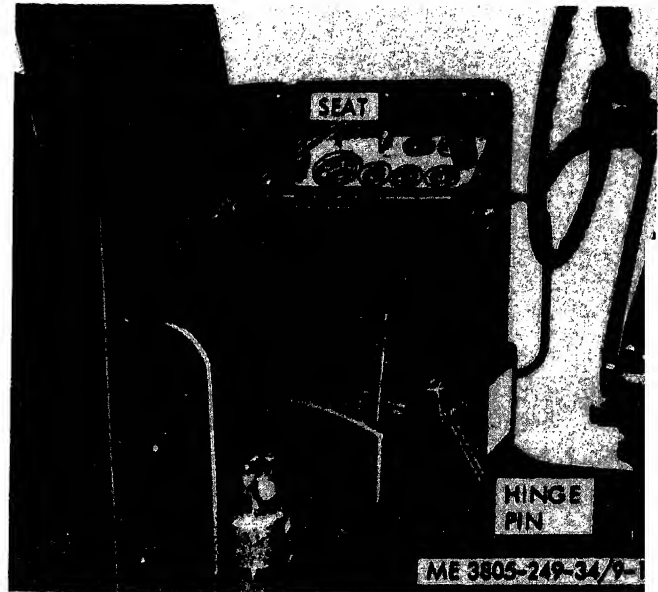


Figure 9-1. Seat assembly.

### Section II. FRAME

#### 9-3. Repair

a. Inspect the frame for cracked or broken welds, distortion and other damage. Weld cracks. Straighten dents. Replace badly damaged frame members.

b. Inspect frame pivot attachments and bearings for cracks, galling, scoring and wear. Smooth surfaces with a stone.

c. Replace distorted or badly damaged supports, brackets, fittings and attachments.

d. Inspect tow and hoist attachment points and repair weld if necessary.

e. Inspect frame hardware and threaded holes for thread damage.



## **APPENDIX A**

### **REFERENCES**

---

#### **A-1. Fire Protection**

**TB 5-4200-200-10**

**Hand Portable Fire Extinguishers for Army Use**

#### **A-2. Lubrication**

**C9100-IL**

**Identification List for Fuels, Lubricants, Oil and Waxes**

**LO 5-3805-249-12**

**Lubrication Order, Grader, Road, Motorized DED, Type I, 12 Ft Blade, Caterpillar Model 120**

#### **A-3. Painting**

**TM 9-213**

**Painting Instructions for Field Use**

#### **A-4. Radio Suppression**

**TM 11-483**

**Radio Interference Suppression**

#### **A-5. Maintenance**

**TM 9-1870-1**

**TB 750-651**

**Care and Maintenance of Pneumatic Tires**

**Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems.**

**TM 5-3805-249-12**

**Operator and Organizational Maintenance Manual Grader, Road, Motorized, DED, Type I, 12 Ft Blade, Caterpillar Model 120.**

**TM 38-750**

**TM 9-6140-200-15**

**The Army Maintenance Management Systems**

**Operation and Organizational, Field and Depot Maintenance: Storage Batteries, Lead Acid Type**

#### **A-6. Shipment and Storage**

**TB 740-93-2**

**Preservation of USAMEC Mechanical Equipment for Shipment and Storage**

**TM 740-90-1**

**Administrative Storage of Equipment**

#### **A-7. Destruction to Prevent Enemy Use**

**TM 750-244-3**

**Procedures for Destruction of Equipment to Prevent Enemy Use**

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